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AUTHOR	Pottenger, Francis M., III; Pottenger, Larma M.
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ABSTRACT

The goal of the Developmental Approaches in Science, Health and Technology (DASH) program is to preserve the curiosity and capture the imagination of all elementary students through an experience of science, technology, and health that engages them in the excitement of exploring and understanding the unknown, inventing and building to solve problems, becoming better able to care for themselves, and gaining basic meaningful knowledge that will enable further school study. This document contains a teacher's guide for 4th grade level. The document is divided into sections based on content. Activities include: (1) Learning; (2) Time, Weather and Sky; (3) Animals; (4) Plants; (5) Food and Nutrition; (6) Health and Safety; (7) Wayfinding and Transportation; (8) Energy and Communication, Conservation, Recycling, and Decomposition; (10) Matter, Space and Construction; (11) Support Materials; (12) Start-up Activities; (13) Activity Plans; (14) Scope and Sequence; (15) Material List; and (16) Complimentary Materials. Each lesson plan includes objectives, background, student role, required materials, product, and procedure information. (Author/YDS)

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Grade 4
Teacher Guide

DASH

Developmental Approaches in Science, Health and Technology

CRDG Curriculum Research & Development Group
University of Hawai'i

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DEVELOPMENTAL APPROACHES IN SCIENCE, HEALTH AND TECHNOLOGY (*DASH*) PROGRAM
GRADE 4 TEACHER GUIDE

PRINCIPAL AUTHORS:	Francis M. Pottenger III and Larma M. Pottenger
CONTRIBUTORS:	Will Kyselka, John Kleinjans, Carol Ann Brennan, Donald B. Young, Arthur R. King, Jr., Craig Doyle, Patricia Lopes

Developmental Approaches in Science and Health (*DASH*) Project

Conceptualizer:	Francis M. Pottenger III
Director:	Francis M. Pottenger III
Associate Director:	Donald B. Young
Assistant Director of National and International Training Operations:	Carol Ann Brennan
Assistant Director of Hawai'i Training Operations:	Sandra K. Shimabukuro
Editor:	Larma M. Pottenger
Illustrators:	Byron Inouye, Donald L. Buchholz
Support Staff:	Heidi Binette, Jeffrey Fujimoto, Valerie Hashimoto, May Izumi, Rachel Lau, Corinne Morisako, Elaine Quinn, Susan Yamzon
Cover Design	Byron Inouye

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Curriculum Research & Development Group
University of Hawai'i
1776 University Avenue
Honolulu, HI 96822

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DASH
PROGRAM LEARNING GOALS

The goals and objectives of DASH are included in the DASH Teacher Guides at each grade level. There are four tiers of goal statements in DASH. The overview, Tier 1, is the DASH program goal for students expressing the program's aspirations for students. At Tier 2 are fifteen program learning goals which categorize general kinds of learning DASH students at all grade levels should work toward to achieve the program goal for students. At Tier 3 are the DASH grade level activity learning goals that are specific for each activity and constitute subcategories of learning within the program learning goals. At the base, Tier 4, are the activity objectives that stipulate what the student should do to reach the activity learning goals. Listed here are the Tier 1 and Tier 2 program learning goals which embrace the entire program. Activity learning goals are found after each cluster's title page and the activity objectives are found within each activity of DASH grade level Teacher Guides.

The DASH program goal for students is to preserve the curiosity and capture the imagination of all elementary students through an experience of science, technology, and health that engages them in the excitement of exploring and understanding the unknown, inventing and building to solve problems, becoming better able to care for themselves, and gaining basic meaningful knowledge that will enable further school study.

The learning goals of DASH are to begin development of and increase students'

1. knowledge and understanding of the foundational concepts of the natural sciences.
2. knowledge and understanding of the concepts fundamental to maintenance of human health.
3. knowledge and understanding of the operations of the technologies.
4. knowledge and understanding of the connectedness of the sciences, technologies, and the needs of society.
5. abilities to inquire about the unknown in the world about them using the tools of science.
6. abilities to invent, design, make, and test solutions to problems.
7. abilities to use the knowledge of science, health, and technology in new situations.
8. abilities to apply language, mathematics, and pictorial conventions as they are needed in science, health, and technology studies.
9. abilities to work cooperatively, collaboratively, and independently as appropriate in science, health, and technology contexts.
10. commitment to the well-being of the natural environment.
11. commitment to the well-being of self and community.
12. awareness of the importance of personal learning about science, health, and technology.
13. learning the ways of science, health, and technology for the excitement and pleasure they bring without concern for gender, ethnicity, or perceived ability.
14. readiness for the science experience of later studies.
15. appreciation for the contributions science, health and technology make to society.

DASH

GRADE FOUR
CLUSTER 1

Learning

4.1.1 The Learning Calendar
4.1.2 Responsibility
4.1.3 Last Year
4.1.4 The Library
4.1.5 Working Together
4.1.6 Things I Can Do for Myself and for Others
4.1.7 Aphorisms
4.1.8 Planning
4.1.9 Survival Game
4.1.10 Concept and Skill Inventory

ACTIVITY 4.1.1 THE LEARNING CALENDAR

OBJECTIVES

The students
- Record data needed in long-term studies in meteorology and astronomy.
- Record important environmental, technological, and scientific events.
- Record important class events.

BACKGROUND

The DASH Learning Calendar is used at each grade level. It is designed to be a class science, health, and technology log and a record of events of importance. On it the students record such things as
- Data for their long-term studies in meteorology and astronomy.
- Things they have learned and important class events.
- Unusual aperiodic events in the natural environment.
- Articles on happenings in science, health, and technology.

Long-Term Data Collection

DASH assumes that students learn through the experience of personally interpreting the world around them. Many phenomena can be interpreted effectively only after extensive bodies of data have been collected. This is particularly the case when meteorological and astronomical phenomena are involved. In DASH, data on the same phenomena are collected over several school years, and each year they are subject to a growing interpretation.

Changing Nature of the DASH Learning Calendar

In kindergarten through grade 2 the calendar record is normally highly pictorial. Pictorial representation allows young students to record and retrieve information more readily. Grade 2 or 3, depending on the development of the particular class of students, is a transition time for movement into a written recording mode. By grade 4 the record will be predominantly a written record.

Things Learned and Events Important to the Class

As DASH activities are concluded, a summary should be placed on the calendar. Whenever appropriate, quantitative data should be recorded in graph form. As part of the mental health (self-esteem and interpersonal bonding) component of DASH, records are kept of things important to individuals and the class as a whole.

Aperiodic Events and Articles

To extend their interest in the world of scientific, health, and technological achievements and unusual natural events, the students are encouraged to add articles to the calendar.

Form of the Calendar

It is suggested that very heavy long-carriage computer paper be used to make the calendar. Such paper produces a record that can be used and stored as a book but can be pulled out to show a continuous record.

Storage of the Calendar

It is suggested that at the end of each school year the calendar be stored in the library so that data can be used in later classes.

The Grade 4 Calendar

The calendar entries for grade 4 are shown in the following table. Newly introduced items are identified by an *I*. Where similar data have been collected in previous grade levels, these grade levels are identified by an *E* for "Experience." Finally, the approximate times when calendar items should be started in grade 4 are shown.

GRADE 4
CALENDAR

CALENDAR ENTRIES	EXPERIENCE					START
	GRADE					
	K	1	2	3	4	
Date						
Day, month, week, year	I	E	E	E	E	B
Season (See Activity 4.2.23.)		I	E	E	E	B
Weather						
Temperature—Fahrenheit and Celsius indoors (See Activity 4.1.1.)	I	E	E	E	E	B
Temperature—high and low outdoors (See Activity 4.1.1.)			I	E	E	S-O
State—cloudy, rainy, sunny, etc. (See Activity 4.2.1.)	I	E	E	E	E	B
Wind direction (See Activity 4.2.3.)		I	E	E	E	B
Wind speed—expanded Beaufort scale (See Activity 4.2.4.)			I	E	I	B
*Rainfall (See Activity 4.2.1.)			I	E	E	S-O
*Snowfall (See Activity 4.2.2.)			I	E	E	AN
Humidity (See Activity 4.2.6.)				I	E	B
*Wind Chill (See Activity 4.2.13.)					I	AN
Clouds (See Activity 4.2.5, 4.2.7, 4.2.8)					I	O
Fronts (See Activity 4.2.11.)					I	N
Weather maps (See Activity 4.2.10.)					I	N
Weather predictions (See Activity 4.2.12)					I	N

CALENDAR ENTRIES	EXPERIENCE					START
	GRADE					
	K	1	2	3	4	
Astronomy						
Moon phases (See Activity 4.1.1.)	I	E	E	E	E	B
Sunrise, Sunset (See Activity 4.2.15.)		I	E	E	E	B
*Equinox, Solstice (See Activity 4.2.14.)			I	E	E	AN
*Eclipses (See Activity 4.2.25.)			I	E	E	AN
Moonrise, Moonset (See Activity 4.1.1.)			I	E	E	B
*Constellations—rising and setting (See Activity 4.2.18.)				I	E	O
*Planets—rising and setting (See Activity 4.2.19.)				I	E	O
Gnomon (See Activity 4.2.16.)					I	S
Special Events						
*Birthdays (See Activity 4.1.1.)	I	E	E	E	E	AN
*School events (See Activity 4.1.1.)	I	E	E	E	E	AN
*Holidays (See Activity 4.1.1.)	I	E	E	E	E	AN
*Local catastrophes (See Activity 4.1.1.)		I	E	E	E	AN
*National catastrophes (See Activity 4.1.1.)				I	E	AN

CALENDAR ENTRIES	EXPERIENCE					START
	GRADE					
	K	1	2	3	4	
*Health news (See Activity 4.1.1.)				I	E	AN
*Science articles (See Activity 4.1.1.)					I	AN
*Technology articles (See Activity 4.1.1.)					I	AN

KEY

A	APRIL	F	FEBRUARY	My	MAY
AN	AS NEEDED	I	INTRODUCED	N	NOVEMBER
B	BEGINNING OF SCHOOL YEAR	Ja	JANUARY	O	OCTOBER
D	DECEMBER	Ju	JUNE	S	SEPTEMBER
E	EXTENDING	Mr	MARCH	*	APERIODIC EVENTS

Beginning the Calendar

Data collection should begin as early as possible in the school year. Equipment needed for measurements can be made by groups of students for the use of the entire class. Group leadership can be provided by students who have had previous experience in DASH.

Season

By grade 4, the students should have dealt with seasons long enough to be able to color-code the calendar. It is suggested that the edges of the paper be given a summer, fall, winter, or spring color stripe so that seasonal segments of the calendar can be identified when seen from the side.

Data Collection and Recording

It is suggested that the responsibility for making entries on the calendar be divided and that groups of two or more students be assigned to each entry on the calendar. Mechanically, this usually solves the problem of people being absent on the day of their assignment. Dividing the responsibility among several groups regularly involves more students, and the class as a whole will have a greater sense of contribution. Further, "many hands make the work go faster."

Making of Equipment and Techniques

The students will need to make weather equipment in the first days of the school year. It is a good idea to have students new to DASH work with those who have had DASH 3 in making the equipment. See Activities 4.2.1–4.2.4.

Sources of Astronomical Data

Astronomical data can be obtained from observation, newspapers, and almanacs. Students who have had previous experience in dealing with astronomical data can begin to practice their predictive skills by checking their predictions against published data.

STUDENT ROLES

Astronomer
Meteorologist
Chronicler

MATERIALS

Learning Calendar
Student Page 4.1.1 THE LEARNING CALENDAR

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Introduce the Learning Calendar by pointing out that again we will be collecting data each day for interpretation. Set up Responsibility Charts and work with the class to list information that is to be collected throughout the year. Point out that other things will be added to the calendar as the year goes on.**

   Date
   - Day, week, month, year
   - Season

   Weather
   - Temperature (Fahrenheit and Celsius indoors)
   - Temperature (Fahrenheit and Celsius outdoors, high and low)
   - Rainfall
   - Wind speed (Beaufort scale)
   - Wind direction
   - Weather clear, clear and hot, partially cloudy, cloudy, rainy, snow, etc. (Some classes will want to add "smoggy" as a modifier.)
   - Humidity (Use cobalt chloride paper. Red means very humid, purple means moderately humid, and blue means dry.)

   Astronomy
   - Sunrise, sunset
   - Moon phases
   - Moonrise, moonset
   - Gnomon reading

Special Events
- Birthdays
- School events
- Holidays
- Health news
- Local catastrophes
- National catastrophes
- Science articles
- Technology articles

2. **During the first days of school have the students organize to collect data.**

   Have them include
   - High and low temperature readings. (Discuss when to take such readings, usually early in the morning and at noon.)
   - Room temperature readings.
   - Weather conditions. (Students can make logos to represent rainy, windy, sunny, hot, cold, etc. Multiple logos can be used for such days as cold, windy, rainy days.)
   - Phases of the moon. (Again logos can be used.)
   - Rainfall. (See Activity 4.2.1.)
   - Wind direction. (See Activity 4.2.3.)
   - Wind speed. (See Activity 4.2.4.)
   - Making a compass using a nail, cork, and bowl of water. (See Activity 4.2.3.)
   - Humidity (See Activity 4.2.6.)

3. **Have the students organize the calendar so that there are assigned places for the items they are to record.**

4. **Start data collection and recording. Have the students use Student Page 4.1.1 to analyze the Learning Calendar.**

Name________________________

Date________________________

DASH

STUDENT PAGE 4.1.1 THE LEARNING CALENDAR

Make a list of uses for the Learning Calendar.

1. ____

____

2. ____

____

3. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

ACTIVITY 4.1.2 RESPONSIBILITY

OBJECTIVES

The students
- Plan for carrying out classroom jobs.
- Record the completion of their assigned responsibilities.

BACKGROUND

This is a follow-up to Activity 4.1.1 THE LEARNING CALENDAR. Because there are many projects and jobs, it is important that a record be kept of who is doing what. A convenient device for keeping records is a responsibility chart listing jobs and workers. The chart can be invented by the students.

It is suggested that a short time on Monday mornings or Friday afternoons be set aside for checking the Class Responsibility Chart. Additional responsibilities can be added to the chart at any time. Most jobs should be rotated regularly. A personal responsibility chart is found on the student page.

STUDENT ROLES

Planner
Recorder

MATERIALS

Markers
Stickers (optional)
Student Page 4.1.2 PERSONAL RESPONSIBILITY CHART

PRODUCTS

Class Responsibility Chart
Personal Responsibility Charts

PROCEDURES

1. Introduce the Class Responsibility Chart.

Demonstrate how the chart works.

Ask such questions as
- Why do we need a Class Responsibility Chart?
- Why is it important to keep a record of who does what jobs?
- What jobs need to be done?
- Why should we report or check off that we have done our job?
- What happens when we do not do the things we have agreed to do?
- What should we do if someone is absent?

2. **Have the students make a list of jobs that need to be done.**

- Discuss the kinds of jobs that need to be done to keep the classroom neat, clean, and running smoothly.
- Make a list of data that should be collected daily.
- Add jobs when there are special projects.

3. **Have the students put the list of jobs on the Class Responsibility Chart.**

Have them
- Decide on a job rotation process.
- Have the students volunteer for the jobs. (Jobs can be assigned if necessary.)
- Post details of jobs in the appropriate job areas.

4. **Discuss the chart with the class.**

Review the list of jobs periodically and rotate the job assignments regularly.

- Ask the students to suggest ways for improvement.

5. **Have the students use Student Page 4.1.2 PERSONAL RESPONSIBILITY CHART to help them meet their own responsibilities.**

EXTENSION

- Have the students report on the kinds of things school employees (janitors, cafeteria workers, others) are responsible for and how they get their assignments.

DASH

Name____________________________

Date____________________________

STUDENT PAGE 4.1.2 PERSONAL RESPONSIBILITY CHART

Complete the chart below.

DATE TO DO	RESPONSIBILITY	DATE DONE

ACTIVITY 4.1.3 LAST YEAR

OBJECTIVES

The students
- Check out their Science Record Books from the library.
- Review what they did in the third grade.
- Review questions that have not yet been answered.

BACKGROUND

In DASH it is important that there be continuity of conceptual development from grade level to grade level. As a device to help ensure this continuity, several records have been designed to be kept and transmitted from one grade to another. These include

- The Learning Calendar
- The Science Record Book
- The Wonder and Discover Book
- The Working Dictionary

The Learning Calendar. The Learning Calendar can be kept and made available to classes in later years when they are studying seasonal and astronomical data. This will be especially important in grade 4.

Working Dictionary. The Working Dictionary ideally will be photocopied at the end of each school year and passed on by you to each grade 5 teacher receiving DASH students. If computers are available, the students can put their definitions directly into a computer file. The printouts can then be photocopied. Grade 4 teachers may receive several Working Dictionaries, which will broaden the richness of ideas as definitions continue to evolve.

Wonder and Discover Book. The Wonder and Discover Book ideally will also be photocopied at the end of the year so that copies can be passed on to each grade 5 teacher receiving DASH students. This record of ideas yet to be probed gives the students a sense of mission as they start the new school year.

Science Record Book. The Science Record Book is the personal record of important information that should be transmitted from one year to the next for longitudinal studies. It normally includes

- Personal growth charts.
- Personal dental records.
- Concepts and skills self-evaluations.
- Records of long-term projects such as decomposition, astronomical observation, and seasonal change projects.

Ideally, the Science Record Books, the Wonder and Discover Book, and the Working Dictionary will be stored over the summer in the library and then checked out in the fall. If the Science Record Books have been stored in the library, they should have a library code put on them by the students. The students should also have made a card for the card file. Retrieval is intended to give the students a sense of the importance of their personal work and to reinforce the idea that science is based on the long-term collection of data. To emphasize the importance of the work, the retrieval should be done with some pomp and ceremony. This could be the time for the librarian to discuss the importance of the library as a repository of the works of knowledge and how to find information in the library.

After retrieving the books the students should take some time to review them.

STUDENT ROLES

Scientist
Librarian

MATERIALS

Science Record Books
Wonder and Discover Book
Working Dictionary
Student Page 4.1.3 LAST YEAR

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Explain to the students that we need to retrieve our Science Record Books, our Wonder and Discover Book, and our Working Dictionary that were stored last year.**

   Ask such questions as
   - Does anyone recall what you did with your books last year? (Get at the idea that the books were stored in the library and a special code was used to identify them.)
   - Does anyone have an idea of how we can find out what that code is? (Probe for the idea that they also made cards for the card file and all we have to do is find our card.)
   - Does anyone have an idea of how we can find our card easily? (Help the students remember that the cards were filed alphabetically.)

2. **Work with the librarian to build the students' library skills.**

   The librarian can do such things as
   - Help get the DASH card file out for the students to find their code.
   - Help coordinate quick access to the storage area where the Science Record Books are to be found.
   - Give a guided tour of the library's resources and explain how they can be accessed.

3. **Have the students review their work from the previous year.**

   Go over the Wonder and Discover Book to see whether the students have
   - Answers to questions left unanswered in the spring.
   - New questions they would like to add after the summer.

   If these are questions of fact, suggest that the student inquiring or anyone else interested do some library research on the question.

4. **Have the students go through their Science Record Books.**

Help them with such questions as

- How did you record what you did last year? (Work to the idea that the Concept and Skill Inventories and the Learning Calendar help tell them what they covered.)
- Judging from last year's growth information, how much do you think you have grown this year?

EXTENSIONS

Have the students

- Report on the library code and how they can find books they want.
- Report on electronic library retrieval systems.

Name________________________

Date________________________

DASH

STUDENT PAGE 4.1.3 LAST YEAR

List new questions for the Wonder and Discover Book.

1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

6. ____________________

7. ____________________

ACTIVITY 4.1.4 THE LIBRARY

OBJECTIVES

The students
- Put their Science Record Books and the class Learning Calendar, Working Dictionary, and Wonder and Discover Book in the library.
- Make identification cards for the books.

BACKGROUND

In DASH, continuity of conceptual development from grade level to grade level is essential. To help ensure this continuity, certain records are designed to be kept and transmitted from one grade to another. These include

- The Learning Calendar
- The Science Record Book
- The Wonder and Discover Book
- The Working Dictionary

The Learning Calendar

The Learning Calendar can be kept in its box in the library for use in subsequent years

Working Dictionary

The Working Dictionary can be photocopied at the end of each school year and passed on to each teacher at the next grade level receiving DASH students. If computers are available, the students can make their entries directly into a computer file. The printouts can then be photocopied.

Wonder and Discover Book

The Wonder and Discover Book should also be photocopied and passed in the same way as the Working Dictionary.

Science Record Book

The parts of the Science Record Book transmitted from one year to the next should be separated from the rest of the students' work. Transmitted information should include the following:
- Personal growth charts.
- Personal dental records.
- Concept and skill self-evaluations.
- Records of long-term projects such as decomposition, astronomical observation, and seasonal change projects.

The Science Record Books, the Wonder and Discover Book, and the Working Dictionary can be stored over the summer in the library so that they can be checked out in the fall.

The Science Record Books should have
- A retrieval code.
- A card for the card file.

STUDENT ROLE

Science librarian

MATERIALS

Science Record Books
Wonder and Discover Books
Working Dictionary
Student Page 4.1.4 LIBRARY CARD

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Explain to the students that we need to store our Science Record Books, our Wonder and Discover Book, and our Working Dictionary for use next fall.**

   Explain that we will need to
   - Code our books using the system that our library uses to identify books. (Work out the code with the librarian ahead of time.)
   - Make a card for the card file so that we can find our books.

2. **Work with the students in a "demonstrate/do" procedure to code their books and make out the library cards.**

3. **Have the students present their Science Record Books and cards to the librarian.**

4. **Have the students practice organizing a shelf of their materials in the classroom and retrieving them using the library cards they have made.**

EXTENSION

- Have the students ask librarians in city or county libraries how they catalog books and magazines.

Name________________________

Date________________________

STUDENT PAGE 4.1.4 LIBRARY CARD

Author ______________

Number ______________

Date ______________

Description

Figure SP 4.1.4 Example of a library card

ACTIVITY 4.1.5 WORKING TOGETHER

OBJECTIVES

The students

- Think about reasons for working cooperatively.
- Think about reasons for working independently.
- Establish a basis for deciding whether tasks should be done cooperatively or independently.

BACKGROUND

This activity is best introduced at the beginning of the year when the students are starting to take over organization of their science work. The activity causes them to think about why some work should be done cooperatively and some independently.

STUDENT ROLE

Project manager

MATERIALS

Student Pages 4.1.5A WORKING TOGETHER
4.1.5B GROUP AND INDEPENDENT TASKS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Introduce the activity by asking why we sometimes work in groups when we are studying health, science, and technology.**

Have the students make a list of reasons. Their list might include
- The need for many hands.
- The need for different talents.
- The need for sharing knowledge.
- The need for sharing ideas.
- The need for sharing resources.
- The need for mutual support.
- The fun of working together.
- The joy of sharing in a common product.
- A preference for group work.
- The best way for instruction under the circumstances.

2. **Ask the students why we sometimes work independently when we are studying health, science, and technology.**

Have the students make a list of reasons. Their list might include the following kinds of ideas:
- The task needs only one person.
- Only one person is available to do the task.
- Individuals have all the talents necessary to carry out the task.
- Individuals have the ideas necessary to carry out the task.
- Resources are sufficient for each individual to carry out the task.
- Individuals are sufficiently motivated to complete the task alone.
- The fun of working alone.
- The joy of doing something completely on one's own.
- A preference for individual work.
- The best way for instruction under the circumstances.

3. **Have the students compare their reasons by asking what makes the two lists different.**

Help them
- See that some reasons are based on needs and some on preference.
- Record the final list on Student Page 4.1.5A WORKING TOGETHER.

4. **Have the students list reasons for deciding to work in groups and reasons for deciding to work independently.**

Have them note that

- Some work naturally requires more than one person. (Have them include such things as big tasks that have to be done in a short period of time, things that require two or more operations to be done at once, and situations needing people with different knowledge.)
- Work that can be done independently does not require someone else's contribution. However, work that be done by one person can usually also be done by groups of people.
- Deciding whether to do something in group or independently is usually a matter of teacher or group preference or convenience.

5. **In later activities have the students apply their logic to decide whether tasks should be done cooperatively in groups or independently. Have them use Student Page 4.1.5B GROUP AND INDEPENDENT TASKS to record their decisions and reasons.**

EXTENSION

- Use the student pages to help decide whether work other than science and health should be done in groups or independently.

DASH

Name___________________________

Date____________________________

STUDENT PAGE 4.1.5A WORKING TOGETHER

REASONS FOR WORKING IN A GROUP	REASONS FOR WORKING INDEPENDENTLY

SP 4.1.5B GROUP AND INDEPENDENT TASKS

Name ____________

Date ____________

Complete the table below. Use a check mark ( ) to indicate whether the task should be done in a group or independently.

TASK TO BE CARRIED OUT	IN A GROUP	INDEPENDENTLY	REASON FOR CHOICE OF METHOD

2.10.94

ACTIVITY 4.1.6
THINGS I CAN DO FOR MYSELF AND FOR OTHERS

OBJECTIVES

The students
- Set goals for helping themselves.
- Monitor their progress in meeting their goals for helping themselves.
- Set goals for helping others.
- Monitor their progress in meeting their goals for helping others.

BACKGROUND

This activity continues the theme of self-sufficiency and community contribution started in kindergarten. It is designed to give the students an opportunity to set goals to help themselves and others and monitor their achievement. The activity should be introduced as early in the year as possible. It can be done at the same time as Activity 4.1.7 APHORISMS.

Ideally, the students will have access to the goals they set for themselves at the end of the third grade. In this activity they monitor their progress in attaining previous goals and set new goals for grade 4. They monitor their progress at the end of the first semester, at the end of grade 4, and at the beginning of grade 5.

The number of goals listed by the students may vary widely. Number should not be a concern. What is important is that the students have goals they can reasonably achieve. Additional goals can be added at the time of monitoring.

By using Student Pages 4.1.6A–C, the students can rate themselves so that they can get a sense of how they are progressing in achieving their goals.

There are two parts to the rating scale, ability and practice:

ABILITY	**PRACTICE**
1. I cannot yet do what my goal calls for.	**1. I do not do what my goal calls for.**
2. I can do what my goal calls for.	**2. I sometimes do what my goal calls for.**
3. I can do what my goal calls for and teach it to someone else.	**3. I usually or always do what my goal calls for.**

STUDENT ROLES

Self-sufficient person
Community contributor

MATERIALS

Student Pages	4.1.6A GOALS FOR THE FIRST SEMESTER 4.1.6B GOALS FOR THE SECOND SEMESTER 4.1.6C GOALS FOR THE SUMMER

PRODUCTS

Goals for the fourth grade

PROCEDURES

1. **If possible, have the students review their third grade goals and evaluate their progress in attaining them.**

2. **Discuss the reasons we might want to help ourselves and others.**

   Ask such questions as
   - Why do we want to do things for ourselves?
   - What disadvantages are there in having to rely on others to help us do something?
   - What are some of the things that even adults need help with? (Get at such things as health decisions—what to do when they get hurt; family decisions—what to do when the family is going to do things together; job decisions—what to do next when a job is completed.)
   - Why do we want to be able to help others?
   - How do you feel when you learn to do something that you have not been able to do for yourself before?

3. **Have the students discuss some of the things that might be achieved during the coming year. List these ideas.**

4. **Have the students use Student Pages 4.5.1A-C to record and monitor their goals for the fourth grade.**

Goals may include things from previous years they have not yet achieved. Honor students' wish to keep some goals private.

Review the rating scale with the students. After each rating has been completed, ask such questions as
- What help, if any, do you need to achieve your present goals?
- What additional goals are you setting?

EXTENSION

- Have the students ask their parents and others how they set their own personal goals.

Name________________________

Date________________________

DASH

STUDENT PAGE 4.1.6A GOALS FOR THE FIRST SEMESTER

List your goals for the first semester. At the end of the semester, use the rating scales below to evaluate your achievement by circling the number that best describes your progress.

ABILITY	PRACTICE
1. I cannot yet do what my goal calls for.	1. I do not do what my goal calls for.
2. I can do what my goal calls for.	2. I sometimes do what my goal calls for.
3. I can do what my goal calls for and teach it to someone else.	3. I usually or always do what my goal calls for.

GOALS FOR THE FIRST SEMESTER

WHAT TO DO FOR MYSELF AND OTHERS	MIDYEAR RATING					
	ABILITY			PRACTICE		
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3

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DASH

Name____________________

Date____________________

STUDENT PAGE 4.1.6B GOALS FOR THE SECOND SEMESTER

List your goals for the second semester. At the end of the school year, use the rating scales below to evaluate your achievement by circling the number that best describes your progress.

ABILITY	PRACTICE
1. I cannot yet do what my goal calls for.	1. I do not do what my goal calls for.
2. I can do what my goal calls for.	2. I sometimes do what my goal calls for.
3. I can do what my goal calls for and teach it to someone else.	3. I usually or always do what my goal calls for.

GOALS FOR THE FIRST SEMESTER

WHAT TO DO FOR MYSELF AND OTHERS	END-OF-YEAR RATING	
	ABILITY	PRACTICE
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3

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DASH

Name________________________

Date________________________

STUDENT PAGE 4.1.6C GOALS FOR THE SUMMER

List your goals for the summer. At the end of the summer, use the rating scales below to evaluate your achievement by circling the number that best describes your progress.

ABILITY	PRACTICE
1. I cannot yet do what my goal calls for.	1. I do not do what my goal calls for.
2. I can do what my goal calls for.	2. I sometimes do what my goal calls for.
3. I can do what my goal calls for and teach it to someone else.	3. I usually or always do what my goal calls for.

GOALS FOR THE FIRST SEMESTER

WHAT TO DO FOR MYSELF AND OTHERS	END-OF-SUMMER RATING	
	ABILITY	PRACTICE
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3

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ACTIVITY 4.1.7 APHORISMS

OBJECTIVES

The students
- Develop aphorisms about good health and safety practices.
- Consider the meaning and continuing value of the aphorisms.

BACKGROUND

Throughout DASH the students are given wide exposure to recommended health and safety practices. Because the list is large, reminding tools are needed to ensure that attention is given to these practices. One device that probably had its beginnings at the camp fires of our first speaking ancestors is the **aphorism**, a pithy statement that captures a truth. Aphorisms can become so much a part of our thinking that they remind us at appropriate moments of some special action that should be considered. Add aphorisms to songs, rhymes, raps, and jingles as devices to help carry the message of appropriate health and safety practices, and we have a powerful arsenal of reminders. Table 4.1.7 gives some examples of aphorisms.

Table 4.1.7 Some aphorisms

	CONCEPTS	EXAMPLES OF APHORISMS
1.	Eat adequate and appropriate food.	Eat right, feel right, grow right.
2.	Go slow on sugar, fat, and salt.	Go slow on sugar, fat, and salt Or a sickly heart will be your fault.
3.	Get eight hours of sleep.	Sleep for eight, Wake up feeling great.
4.	Replace the water you lose each day by drinking adequate amounts of liquid (6–8 glasses of water).	Six glasses in winter and eight in summer Are my body's natural plumber.
5.	Wash your hands *before* eating or handling food and *after* using the toilet.	Wash hands before eating or fixing a hurt, After using the toilet or working in dirt.
6.	Keep your lips in the water and off the fountain.	Mouth in the water, And not in the fountain.
7.	Attend to tooth care. Brush 20 times up and 20 down. Don't forget to floss.	Brush 20 times up And 20 times down. Floss in between To complete the routine.
8.	Attend to skin and hair care.	Healthy skin and hair are clean skin and hair.

9.	Wear clothes suitable for the weather and time of day.	Winter clothes feel comfortably warm. Summer clothes feel comfortably cool.
10.	Make regular use of the toilet.	When nature calls, We listen and go. We wipe and flush, And wash just so.
11.	Make your environment safe and clean.	A clean and safe space Is a great workplace.
12.	Seek help in treating wounds.	Every wound requires inspection. Untreated wounds invite infection.
13.	When sick, stay away from others.	When sick, just stay home. Don't let your germs roam.
14.	Cover your nose and mouth when sneezing and coughing.	Don't sneeze or cough with the cover off.
15.	Share with those about you.	Sharing with others is caring for others.
16.	Remember your responsibilities and carry them out.	Get the job done, Then have fun.
17.	Plan ahead.	Plan when you can.
18.	Help those who need help.	Lend a hand, When you can.
19.	Know the emergency phone number.	Remember 911 When emergencies come.
20.	Play a fair game.	Play fair with others, and they'll play fair with you.
21.	Put things away when you're finished.	Finished for today? Then put your things away.
22.	Treat all living things with respect.	Respect all living things.
23.	Exercise 20–30 minutes a day.	Exercise 20 minutes for heart insurance. Thirty minutes for heart endurance.
24.	Stay away from alcohol, tobacco, and recreational drugs.	A smoker's a choker. There's no excuse for drug abuse. Alcohol makes your system stall.
25.	If you really know and understand something, you can teach it.	If you really know and understand, Teach and give someone a hand.

The students are to compose or recall aphorisms for each of the concepts listed. Aphorisms used previously in DASH are included here. This activity should be used at the end of each semester.

STUDENT ROLE

Health consultant

MATERIALS

Student Page 4.1.7 APHORISMS TO LIVE BY

PRODUCTS

Aphorisms about health and safety

PROCEDURES

1. **For each of the listed concepts. Have the students make up new aphorisms or recall those learned earlier. Have them use Student Page 4.1.7 APHORISMS. Add new concepts as needed.**

2. **Discuss the meaning and continuing value of the aphorisms.**

EXTENSION

- Find aphorisms that others have made up about health practices, for example, "An apple a day keeps the doctor away."

Name________________________

Date________________________

DASH

STUDENT PAGE 4.1.7 APHORISMS TO LIVE BY

Fill in an aphorism for each concept.

SOME APHORISMS TO LIVE BY

	CONCEPTS	APHORISMS
1.	Eat adequate and appropriate food.	
2.	Go slow on sugar, fat, and salt.	
3.	Get eight hours of sleep.	
4.	Replace the water you lose each day by drinking adequate amounts of liquid (6–8 glasses of water).	
5.	Wash your hands *before* eating or handling food and *after* using the toilet.	
6.	Keep your lips in the water and off the fountain.	

Name ______________________

7.	Attend to tooth care. Brush 20 times up and 20 down. Don't forget to floss.	
8.	Attend to skin and hair care.	
9.	Wear clothes suitable for the weather and time of day.	
10.	Make regular use of the toilet.	
11.	Make your environment safe and clean.	
12.	Seek help in treating wounds.	
13.	When sick, stay away from others.	
14.	Cover your nose and mouth when sneezing and coughing.	
15.	Share with those about you.	
16.	Remember your responsibilities and carry them out.	

Name ______________________

17.	Plan ahead.	
18.	Help those who need help.	
19.	Know the emergency phone number.	
20.	Play a fair game.	
21.	Put things away when you're finished.	
22.	Treat all living things with respect.	
23.	Exercise 20–30 minutes a day.	
24.	Stay away from alcohol, tobacco, and recreational drugs.	
25.	If you really know and understand something, you can teach it.	

ACTIVITY 4.1.8 PLANNING

OBJECTIVES

The students
- Make and maintain a class planning calendar.
- Make and maintain personal planning calendars.

BACKGROUND

This activity is an ongoing part of the time sequence. It encourages the students to anticipate and plan for holidays, vacations, birthdays, major school events, and classroom projects.

DASH involves the students in classroom planning to help them develop a sense of the future. To do this, the students use a Class Planning Calendar, a standard calendar on which all important events are written. It shows the whole year on one large sheet. The Planning Calendar should include regularly scheduled planning sessions.

STUDENT ROLE

Planner

MATERIALS

Markers
Stickers (optional)
Student Page 4.1.8 PERSONAL PLANNING CALENDAR

PRODUCTS

Class Planning Calendar
Personal Planning Calendars

PROCEDURES

1. **Introduce the Class Planning Calendar on the first planning day.**

   Discuss the need to know about future events and how they can be recorded.

2. **Have the students record major events for the year.**

   Have them include such things as
   - Birthdays.
   - Holidays.
   - School events.
   - Classroom events.
   - Vacation days.

3. **Regularly help the students update the Class Planning Calendar and plan for upcoming events and projects.**

   Have the students
   - Update the Planning Calendar at regular periods.
   - Make any plans necessary for events and projects.

4. **Have the student keep a personal planning calendar with homework assignments and other events in which they are to be involved.**

EXTENSION

- Have the students check their class calendar against the school calendar kept in the office.

Name________________________

Date________________________

DASH

STUDENT PAGE 4.1.8 PERSONAL PLANNING CALENDAR

Complete the table below.

DATE DUE	HOMEWORK/EVENT	DATE COMPLETED

ACTIVITY 4.1.9 SURVIVAL GAME

OBJECTIVES

The students
- Are introduced to a survival simulation through a story.
- Plan their learning in the light of survival needs.

BACKGROUND

In many schools the fourth grade is a time to study the aboriginal or first peoples of the Americas and the Pacific Islands. The DASH 4 study of technology can be used to complement these studies.

At the time of contact with Europeans, aboriginal technologies of the Americas and the Pacific were advanced, diverse, and especially adapted to the environments in which they were employed. Gold, silver, copper, and bronze were worked with great skill in parts of Latin America. However, stone, bone, wood, and clay were the principal materials of construction throughout the two continents and the Pacific. In places there were vast cities with massive stone and earthen structures. Aqueducts often carried water great distances to irrigate arid land. In contrast, in other places peoples remained nomadic hunter-gathers.

Many DASH 4 activities lend themselves to a generic study of technologies common to these aboriginal peoples and, indeed, to much technology that comes down to us today. The SURVIVAL GAME sets the stage for the study of aboriginal technology. The students listen to a scenario about a group of youths who are cut off from their people and must learn how to use knowledge of plants, animals, and the physical environment; make tools of natural materials; and build artifacts to survive.

In this activity the students, acting out the story, are given the task of determining what they need to learn in order to survive. Their first task is to enumerate the basic biological requirements that must be accounted for in human survival. These include the needs for water, food, sleep, elimination, thermal protection, injury protection, sanitation, reproduction, exercise, mobility, learning, communication, and interpersonal bonding. This same listing will be used in preparing for a Martian voyage in DASH 6.

The students are then give a listing of things that you, their honored teacher, can lead them to learn, and they order this listing to ensure that essential things are done first. The listing includes the major content areas of the year's work and can be used as a general guide to study.

Two scenarios are offered—one set in continental America and the other in Polynesia. Select one.

Simulation Settings

During the Ice Ages vast amounts of ocean water were tied up in glaciers, and the sea's level was much lower than it is today. Theory tells us that during part of the last Ice Age, which ended about 10,000 years ago, dry land emerged between Asia and America. Over this bridge people were able to travel from one continent to the other. Evidence now indicates that the ancestors of today's Eskimo and Indian people probably first crossed from Asia some 20,000 to 40,000 years ago. At that time mammoths, saber-toothed tigers, and other giant animals roamed the land. When the weather changed, the land bridge submerged, the great mammals were replaced by the smaller animals we know today, and the people from Asia were isolated in the new land. Being nomadic hunters, they migrated throughout North and South America. The scenario used here could logically have taken place anytime after the melting of the continental glaciers, but at a time when the Americas were first being populated.

Migration to the islands of the Pacific came much later, starting from Southeast Asia 3,000–4,000 years ago. The motivation for this nautical adventure is not known. We do know that Polynesians were builders of great voyaging canoes; workers of stone, bone, clay, and wood; weavers of mats and makers of cloth; and observers with a profound knowledge of weather and sky. The second scenario could have taken place almost anytime before or during the time of contact with early European explorers. The island described in the tale is like New Zealand, which Polynesians began to populate about 800 years ago.

STUDENT ROLES

Survivalist
Aboriginal Americans
Aboriginal Polynesians

MATERIALS

Student Page 4.1.9 SURVIVAL GAME

PRODUCTS

Completed Student Pages

CONTINENTAL AMERICAN SCENARIO

PROCEDURES

1. Provide background for the simulation.

The following scenario describes the situation, environment, and experience of "The People," half-taught youths who have escaped a great fire with you, their venerable teacher, to find a new home. Teacher and youths are gathered in traditional council. Read the scenario to the class, assuming the role of the venerable teacher.

PART I: CONTINENTAL AMERICAN SCENARIO

As you know, our story began two moon cycles after the day of shortest noon shadow and the shortest night which fell at the time of the full moon. Your parents had gone to the great plain beyond the forest to hunt, leaving you in my charge to instruct. There had been little rain when a great fire drove us from the land of our ancestors into the mother of rivers where we found a log raft and escaped.

On our raft we drifted far down the river before we came to rest on the other side. When we looked back, we could see the fire still raging. There was no return. We remembered the command spoken by our wise ones who lived before us: "When fire and smoke cover the setting sun, travel with the young into the land of the morning and start anew."

All our possessions were given to the spirit of the fire in exchange for our lives. We have nothing save our meager clothing and the sticks and rocks we have picked up on our way. We have walked from the full moon to the dark of the moon to the first quarter moon beyond, eating the first berries and grains and the slow creatures of the forest, always seeking the land of the morning. The weather has been warm, and we have not suffered from the night.

Now we have come to what is surely the place we were commanded to find. There is a high mountain range above us that holds up the morning sun.

- There are free-flowing streams, lakes, and open grassy meadows.

- Pine, spruce, oak, maple, birch, walnut, and chestnut, hazel nut, and poplar trees are everywhere.
- Sandstone and hard flint rock are found in the hillsides.
- Fish, turtles, and frogs are abundant in the streams.
- Birds are in plenty now, but ducks, geese, and cranes will go when the forest turns orange and the snow winds first whisper. However, the songs of their small forest cousins will cheer us through the cold of ice and snow.
- Deer, bears, beavers, opossums, rabbits, squirrels, wolves, lynxes, foxes, cats, and snakes share the forest.
- Rain comes regularly now, and we have been fortunate to find caves along a stream.

If we are to survive here, we must start with skills that have come down to us from our ancestors. From them

- We know how to find and preserve the food of the land.
- We know how to make fire.
- We have learned to domesticate and raise animals,
- We have mastered the use of rock, hide, bone, wood, and clay.
- We have mastered how to measure and equally divide the things about us.
- We can read the night sky to tell the seasons.

2. **Continue to play the role of the venerable teacher. Give the charge to "The People" in the council through the continuing story.**

PART II: CONTINENTAL AMERICAN SCENARIO
By our tradition, I, your teacher, lead you to learn. What you decide to learn will determine our fate.

But first you must find out how much time we have till the cold days of fall and winter. Then we must think of all the things that must be considered if we are to survive on this land. (Have The People use Student Page 4.1.9 for recording.

- Have The People determine the date of this council. (They started two moon cycles after the summer solstice, or about August 20, and have traveled from the full moon to the new moon and on to the quarter moon, or 3/4 of a cycle of about 21 days. The date is about September 10.)
- Have The People determine how much time they have until fall and winter weather sets in. (Probably 1-1/2 to 2 months.)

- Have The People list the basic biological needs that they must satisfy in order to survive. (These include need for air, water, food, sleep, elimination, thermal protection, injury protection, sanitation, reproduction, exercise, mobility, learning, communication, and interpersonal bonding.)
- Have The People list the six most pressing needs and order them according to how long we can survive without attending to them. The list should run from crucial to least pressing. (Get agreement that pressing needs would be for air, thermal protection, injury protection, water, sleep, elimination, and food.)
- Have The People record their final lists on Student Page 4.1.9.

3. **Continue to play the role of the venerable teacher. Go over the following list of information and skills that you can lead The People to learn. Have them use Student Page 4.1.9.**

- **I can lead you to learn the ways of the seasons, weather, and the sky.**
  (Cluster 2, TIME, WEATHER, AND SKY)
- **I can lead you to learn the ways of birds and other animals.**
  (Cluster 3, ANIMALS)
- **I can lead you to learn the way of plants.**
  (Cluster 4, PLANTS)
- **I can lead you to learn about food that nourishes you.**
  (Cluster 5, FOOD AND NUTRITION)
- **I can lead you to learn how to find good rock for working.**
  (Activities 4.10.4 COLLECTING ROCKS. 4.10.5 HARDNESS OF ROCKS. 4.10.6 SPECIFIC GRAVITY, 4.10.7 ROCKS AND SHARP EDGES)
- **I can lead you to learn ways to work rock.**
  (Activities 4.10.8 MAKING TOOLS FROM ROCK, 4.8.4 PRESSURE, SHARP EDGES, AND POINTS, 4.10.9 MAKING FISHING TOOLS)
- **I can lead you to learn ways to fashion boats and capture the wind.**
  (Activities 4.8.2 FRICTION, 4.8.3 STREAMLINING, 4.7.1 BOAT DESIGN, 4.7.2 WIND AND SAILS)
- **I can lead you to learn the ways of the hunt.**
  (Activities 4.8.5 ENERGY OF FALLING OBJECTS, 4.8.6 CIRCLES AND SPEED)

- **I can lead you to learn the mysteries of fire.**
  (Activities 4.6.4 SAFETY AND PUTTING OUT FIRES, 4.6.5 MAKING A FIRE, 4.6.6 THINGS THAT BURN, 4.10.13 AIR AND FIRE, 4.10.14 FIRE AND OXYGEN, 4.10.15 PROPERTIES OF GASES)
- **I can lead you to learn how to make pottery.**
  (Activities 4.10.11 CLAY, 4.10.12 FIRE AND POTTERY)
- **I can lead you to learn how to measure and divide the things about you into many equal parts.**
  (Activities 4.10.1 LINEAR MEASUREMENT, 4.6.1 GROWTH CHART AND AREA MEASUREMENT, 4.10.2 VOLUME MEASUREMENT, 4.10.3 MASS MEASUREMENT)
- **I can lead you to learn how to raise and understand animals.**
  (Activities 4.3.1 PET CARE, 4.3.2 THE UNINCUBATED EGG, 4.3.3 CHICK EMBRYOLOGY, 4.3.4 RAISING SMALL MAMMALS, 4.3.5 HOUSING PET MAMMALS, 4.3.6 WEEKEND CARE OF PET MAMMALS, 4.3.7 PAIRING PET MAMMALS, 4.3.8 REPRODUCTION OF PET MAMMALS, 4.3.9 PET BABY CARE)
- **I can lead you to learn many other things as time passes.**

4. **Have The People work in small groups to decide the order in which they need to learn these things of survival. Then have them come together to discuss with you, their teacher, what they have decided. Have them use Student Page 4.1.9 to report their ordering.**

   - Analyze the wishes of The People, working for agreement on a sequence that is close to the one you wish to pursue.
   - Where agreement is not possible, explain that by tradition you, the teacher, must keep in mind The People's recommendations but will have to be the one to decide what will be done.

EXTENSION

- Have The People use maps and globes to suggest where the starting and final locations of the simulations might be. (The People could have started from any of the great rivers of the eastern United States to the west of a mountain range. They would have started at a point about 75–100 miles from the range. The walking distance would probably have been no more than four or five miles a day for a band of scavenging youths.)

POLYNESIAN SCENARIO

PROCEDURES

1. Provide background for the simulation.

The following scenario describes the situation, environment, and experience of "The People," half-taught youths who have escaped conquest of their island with you, their Kapuna or teacher, to find a new home. Teacher and youths are gathered in council. Read the scenario to the class, assuming the role of the Kapuna.

PART 1: POLYNESIAN SCENARIO

As you know, our story began the day before the celebration of the shortest noon shadow and the shortest night which fell five days after the new moon. The great navigator Kami and I had taken you to the far side of our island to ride the marvelous double-hulled canoe he and his crew were provisioning for their next voyage to the south. The walk was long, and the black lava of the mountain trail was almost too hot for your feet. But late in the afternoon we arrived at the bay where the boat stood ready to sail. Kami had us all plunge into the cooling waves and then bathe off the salt in the stream. Then he and the crew fed us. By the light of an evening fire they told bold tales of an island to the south under a long white cloud that they once saw on the horizon before being driven back to the north by a terrible chilling storm.

In the morning the huge canoe was pushed into the water with all of us aboard. We could feel the greatness of Kami as the sail opened to the wind and we started around the island. It was then that the sharp-eyed Lapuna saw a figure running along the beach waving frantically at us. Kami turned the great canoe and came in closer to find Nano the runner. "Peliane! Peliane! Peliane!" Nano shouted. It was then that we could see a line of men rushing down the high mountain trail, sunlight reflecting off polished wooden spears. "Peliane!" screamed Kami. Grabbing up an adz and shield, he leaped into the water followed by his crew. We were alone. On the shore Kami turned and shouted "Sail south!" and ran into the trees beyond the beach.

Just then a gust of wind filled the sail. As if Kami still held the mighty steering oar, we were carried through the reef out into the open ocean. Almost immediately the sea began to churn, and the sky turned black and our island was lost from view. We pulled down the sail and lashed ourselves to the deck, where we clung, seasick and half-drowned, all that day and into the night as the ocean rushed over and around us.

As the storm subsided, we huddled under the wet fibers of the sail until morning. When the sun rose, we could see no land. We found that Kami must have anticipated such a storm for little of the ocean had entered the covered hull and provisions, including the water gourds, were well protected. Though we could sail east and west beneath our island's star and possibly find our home, you are but children and would be unable to fight the Peliane who surely must have taken our island. It was from them that our ancestors fled five generations ago.

So we followed Kami's command and sailed south. You learned quickly the ways of sailing through the empty sea. First the days and nights were warm, then they got cooler. Our only company was a graceful frigate bird that perched by night upon the mast and flew before us through the day. You shared with him our provisions, and after two cycles of the moon he led us to this vast island under a long white cloud where we landed but two days ago. Surely this is the place Kami saw.

It is cool at night but warm in the day. Against the night we have wrapped ourselves in the leaf cloaks left by Kami's crew. The land is green with lush vegetation.

- There are flowing streams, and when we climbed the sea cliff we could see a huge pond.
- Coconut, pandanus, and other trees we do not know are all about us.
- Hard basalt and porous aa are found in the hillsides.
- The reef is full of fish, crabs, limpets, and other creatures. Turtles' shells tell us of their presence. There is an abundance of birds. One in particular is of monstrous size and seems completely unafraid of us as we approach.
- The dogs and pigs that we know have not been found.
- There is no evidence of any other people in this great place.

If we are to survive here, we must start with skills that have come down to us from our ancestors. From them
- We know how to find and preserve the food of the land.
- We know how to make fire.
- We have learned to domesticate and raise animals,
- We have mastered the use of rock, hide, bone, wood, and clay.
- We have mastered how to measure and equally divide the things about us.
- We can read the night sky to tell the seasons.

2. **Continue to play the role of the Kapuna. Give the charge to The People in the council through the continuing story.**

PART II: POLYNESIAN SCENARIO
By our tradition, I, your teacher, lead you to learn. What you decide to learn will determine our fate.

But first you must think of all the things that have to be considered if we are to survive in this land. (Have The People Use Student Page 4.1.9 for recording.)
- Have The People determine the date of this council. (The shortest night is at the summer solstice. Two cycles of the moon later would be about two months, or around August 20, late summer, if they started in the Northern Hemisphere. If they started in the Southern Hemisphere, it would be about February 20, still late summer.)
- Have The People determine how much time they have until colder weather sets in. (This will be an interesting determination. If the canoe is on the same side of the equator as when The People started, it will be several months away. If they have crossed over the equator, they are into spring. Have The People recall what happened to the temperature as they sailed south. It was warm and then got progressively cooler, indicating that they were on the same side of the equator but in the Southern Hemisphere. If they had crossed the equator, it would probably have gotten quite hot before getting cold.)
- Have The People list the basic biological needs they must satisfy in order to survive. (These will include need for air, water, food, sleep, elimination, thermal protection, injury protection, sanitation, reproduction, exercise, mobility, learning, communication, and interpersonal bonding.)

- Have The People list the six most pressing needs and order them according to how long we can survive without attending to them. The list should run from the most crucial to least pressing. (Get agreement that the most pressing needs would be for air, thermal protection, water, sleep, elimination, and food.)
- Have The People record their final lists on Student Page 4.1.9.

3. **Continue to play the role of the Kapuna. Go over the following list of information and skills that you can lead The People to learn. Have them use Student Page 4.1.9.**

- **I can lead you to learn the ways of the seasons, weather, and the sky.**
  (Cluster 2, TIME, WEATHER, AND SKY)
- **I can lead you to learn the ways of birds and other animals.**
  (Cluster 3, ANIMALS)
- **I can lead you to learn the ways of plants.**
  (Cluster 4, PLANTS)
- **I can lead you to learn about food that nourishes you.**
  (Cluster 5, FOOD AND NUTRITION)
- **I can lead you to learn how to find good rock for working.**
  (Activities 4.10.4 COLLECTING ROCKS. 4.10.5 HARDNESS OF ROCKS. 4.10.6 SPECIFIC GRAVITY, 4.10.7 ROCKS AND SHARP EDGES)
- **I can lead you to learn ways to work rock.**
  (Activities 4.10.8 MAKING TOOLS FROM ROCK, 4.8.4 PRESSURE, SHARP EDGES, AND POINTS, 4.10.9 MAKING FISHING TOOLS)
- **I can lead you to learn ways to fashion boats and capture the wind.**
  (Activities 4.8.2 FRICTION, 4.8.3 STREAMLINING, 4.7.1 BOAT DESIGN, 4.7.2 WIND AND SAILS)
- **I can lead you to learn the ways of the hunt.**
  (Activities 4.8.5 ENERGY OF FALLING OBJECTS, 4.8.6 CIRCLES AND SPEED)
- **I can lead you to learn the mysteries of fire.**
  (Activities 4.6.4 SAFETY AND PUTTING OUT FIRES, 4.6.5 MAKING A FIRE, 4.6.6 THINGS THAT BURN, 4.10.13 AIR AND FIRE, 4.10.14 FIRE AND OXYGEN, 4.10.15 Properties of Gases)
- **I can lead you to learn how to make pottery.**
  (Activities 4.10.11 CLAY, 4.10.12 FIRE AND POTTERY)

- **I can lead you to learn how to measure and divide the things about you into many equal parts.**
  (Activities 4.10.1 LINEAR MEASUREMENT, 4.6.1 GROWTH CHART AND AREA MEASUREMENT, 4.10.2 VOLUME MEASUREMENT, 4.10.3 MASS MEASUREMENT)
- **I can lead you to learn how to raise and understand animals.**
  (Activities 4.3.1 PET CARE, 4.3.2 THE UNINCUBATED EGG, 4.3.3 CHICK EMBRYOLOGY, 4.3.4 RAISING SMALL MAMMALS, 4.3.5 HOUSING PET MAMMALS, 4.3.6 WEEKEND CARE OF PET MAMMALS, 4.3.7 PAIRING PET MAMMALS, 4.3.8 REPRODUCTION OF PET MAMMALS, 4.3.9 PET BABY CARE)

4. **Have The People work in small groups to decide the order in which they need to learn these things to survive and then come together to report to you, the Kapuna, what they have decided. Have them use Student Page 4.1.9 to report their ordering.**

   - Analyze the wishes of The People, working for agreement on a sequence acceptable to you.
   - Where agreement is not possible, explain that by tradition you, the Kapuna, must keep in mind The People's recommendations but will have to be the one to decide what will be done.

EXTENSIONS

- Have The People use maps and globes to suggest where the starting and final locations of the simulations might be. (The Tongan, Society, and Cook islands could be reasonable starting places and New Zealand a likely landing place. New Zealand is known as the land of the long white cloud.)

Name____________________

Date____________________

STUDENT PAGE 4.1.9 SURVIVAL GAME

1. Record the date of the council. __________

2. Explain how you arrived at the date.

3. Record how much time there will be before the onset of fall weather. ____________

4. Explain how you made your determination.

5. List the basic biological needs that must be satisfied in order to survive.

6. List the six most pressing needs listed above. Put them in order according to how long we can survive without attending to them.

1. ______ 4. ______

2. ______ 5. ______

3. ______ 6. ______

7. Below is a list of the things that your teacher can lead you to learn about. List them in the order in which you should learn them.
   - The ways to the seasons, weather, and the sky.
   - The ways of birds and other animals.
   - The ways of plants.
   - Food that nourishes you.
   - Good rock for working.
   - Ways to work rock.
   - Ways to fashion boats and capture the wind.
   - Ways of the hunt.
   - The mysteries of fire.
   - The making of pottery.
   - How to raise and understand animals.
   - Ways to measure and equally divide the things around us.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________
11. ______________________________
12. ______________________________

ACTIVITY 4.1.10 CONCEPT AND SKILL INVENTORY

OBJECTIVES

The students
- Assess their understanding of selected concepts.
- Assess their ability to perform selected skills.

BACKGROUND

This activity is a continuation of the DASH assessment component that begins in kindergarten and extends through the sixth grade. The activity is designed to make the students aware of concepts in DASH they understand and skills they have mastered so that they can monitor their own work and achievement. The instrument used is called the Concept and Skill Inventory.

Concepts

The term **concept** is used in DASH to refer to the ideas and connections captured in a word or phrase. A concept in DASH is a growing thing. A kindergartner's concept of seasons, for example, is less rich than a fourth grader's.

In grade 4 the students distinguish four levels of understanding with teaching as the highest level of achievement.

CONCEPTS

0 No understanding of the concept
1 Beginning to understand the concept
2 Good understanding of the concept
3 Can teach someone else the concept

Skills

The term **skill** in DASH refers to the ability to gain and use knowledge or perform learned physical tasks effectively. Starting in fourth grade, DASH skills are divided into three categories: mechanical/intellectual, interpersonal, and motivational skills. A skill, too, is a growing thing. Normally a fourth grader is able to measure mass with greater precision and accuracy than a second grader.

Mechanical/intellectual skills—The term refers to the ability to manipulate equipment and process information.

MECHANICAL/INTELLECTUAL SKILLS
0 No evidence of the skill
1 Beginning to use the skill
2 Good use of the skill
3 Can teach someone else the skill

Interpersonal skills—The term refers to the demonstrated ability to relate to others. This is a new category added at grade 4.

INTERPERSONAL SKILLS
0 No evidence of the skill
1 Beginning to use the skill
2 Good use of the skill
3 Can teach someone else the skill

Motivational skills—The term refers to the demonstrated ability of a person to achieve self-directed goals. This is a new category added at grade 4.

MOTIVATIONAL SKILLS
0 No evidence of the skill
1 Beginning to use the skill
2 Has good use of the skill
3 Can teach someone else the skill

This part of the inventory gives the teacher the most insight into how the students think about themselves. Whether to include it with the permanent records is left to the teacher's discretion.

Use of the Instrument

It is suggested that the teacher and the students use the inventory independently to rate concepts and skills. Discrepancies can then be resolved by discussion. If there are questions about rating differences, the students can be asked to teach the concept or skill to the teacher. The level of understanding will readily emerge. The students should be encouraged to refine their understanding and skills by attempting to teach others.

Concepts and Skills Not Covered

The students may not get to explore all the concepts and skills listed on the inventory in the school year. This should not limit the use of the instrument. Some students will gain understanding of concepts and skills outside formal instruction and should be credited for such learning. Concepts or skills that have not been presented in class can be considered as goals for future learning.

Reporting

The Concept and Skill Inventory can be used as a reporting instrument for the home and school. If it is used as a replacement of standard reporting forms, some communication should accompany the inventory describing how it should be interpreted.

Additional Concepts and Skills

The concepts and skills listed in the instrument are but a sampling. The teacher may make additions, substitutions, or deletions as needed.

STUDENT ROLE

Evaluator

MATERIALS

Student Page 4.1.10 DASH FOURTH GRADE CONCEPT AND SKILL INVENTORY

PRODUCTS

Completed Concept and Skill Inventories

PROCEDURES

1. **Discuss the purpose of Student Page 4.1.10 DASH FOURTH GRADE CONCEPT AND SKILL INVENTORY.**

   Include such things as
   - The inventory allows students to tell what they think they know.
   - The inventory allows teachers to check their personal observations with those of students.
   - The inventory indicates what is already known and what has yet to be studied.

Work with the students to develop

- A working definition of the term **concept**. (Work to the idea of the connections that are captured in a word or phrase. A concept includes definitions and associations and may include such things as identification of parts, operation of parts, uses, and differences between and likeness to other things.)
- A working definition of the word **skill**. (Work to the idea of an ability to gain and use knowledge effectively or perform some learned physical feat.)
- A working definition of the word **interpersonal**. (Work to the idea of working together.)
- A working definition of the word **motivation**. (Work to the idea of a personal drive to achieve a goal.)

2. **Go over examples of each level of the inventory. Read the instructions with the students and answer any questions.**

3. **Privately discuss any differences between your perception of students' understanding and performance and their own.**

4. **Have the students keep the completed inventory in their Science Record Book.**

EXTENSION

- Have the students keep a list of additional concepts and skills they have mastered.

TEACHER RECORD
DASH FOURTH GRADE CONCEPT AND SKILL INVENTORY

CONCEPTS	NAMES OF STUDENTS														
KEY 0 Has no understanding of the concept 1 Is beginning to understand the concept 2 Has good understanding of the concept 3 Can teach someone else the concept															
1. Cloud types															
2. Weather maps															
3. Weather fronts															
4. Wind chill															
5. Lightning															
6. Gnomon															
7. Zodiacal Band															
8. Planet															
9. Constellation															
10. Standard time															
11. Latitude															

4.1.10—6

CONCEPTS contd

NAMES OF STUDENTS

KEY 0 Has no understanding of the concept 1 Is beginning to understand the concept 2 Has good understanding of the concept 3 Can teach someone else the concept															
12. Sundial															
13. Seasons															
14. Greenwich															
15. Incubation															
16. Embryology															
17. Reproduction															
18. Animal growth															
19. Animal development															
20. Animal behavior															
21. Digestive system															
22. Food Pyramid system															
23. Respiratory system															

CONCEPTS contd

NAMES OF STUDENTS

KEY 0 Has no understanding of the concept 1 Is beginning to understand the concept 2 Has good understanding of the concept 3 Can teach someone else the concept															
24. Digestion															
25. Anatomy															
26. Migration															
27. Hibernation															
28. Annual Plants															
29. Perennial plants															
30. Fungus															
31. Nutrients															
32. Force															
33. Streamlining															
34. Energy															
35. Friction															
36. Speed															

CONCEPTS contd

NAMES OF STUDENTS

KEY 0 Has no understanding of the concept 1 Is beginning to understand the concept 2 Has good understanding of the concept 3 Can teach someone else the concept															
37. Hardness															
38. Specific gravity															
39. Clay															
40. Fire safety															
41. Linear measure															
42. Area measure															
43. Volume measure															
44. Mass measure															
45. Gases															
46. Liquids															
47. Solids															
48. Science															
49. Technology															

SKILLS	NAMES OF STUDENTS														
KEY 0 No evidence of the skill 1 Is beginning to use the skill 2 Has good use of the skill 3 Can teach someone else the skill															
MECHANICAL/INTELLECTUAL SKILLS															
1. Divide a distance into 10 equal parts															
2. Make a balance															
3. Measure area															
4. Measure mass															
5. Measure volume															
6. Measure specific gravity															
7. Make a hardness scale															
8. Put out a fire safely															

MECHANICAL/INTELLECTUAL SKILLS contd

NAMES OF STUDENTS

KEY 0 No evidence of the skill 1 Is beginning to use the skill 2 Has good use of the skill 3 Can teach someone else the skill															
9. Make a fire safely															
10. Determine the height of clouds															
11. Determine pH															
12. Preserve food															
13. Determine latitude															
14. Determine when it's local noon															
15. Make a sundial															
16. Identify different cloud types															

MECHANICAL/INTELLECTUAL SKILLS contd

NAMES OF STUDENTS

KEY 0 No evidence of the skill 1 Is beginning to use the skill 2 Has good use of the skill 3 Can teach someone else the skill															
17. Predict weather															
18. Find the North Star															
19. Locate planets in the sky															
20.															
21.															
22.															
23.															
24.															

INTERPERSONAL SKILLS

NAMES OF STUDENTS

KEY 0 No evidence of the skill 1 Is beginning to use the skill 2 Has good use of the skill 3 Can teach someone else the skill															
1. Carry out responsibilities															
2. Share things															
3. Wait turns															
4. Have patience with others															
5. Help others															
6. Work in groups															
7. Lead in groups															
8. Share ideas															

INTERPERSONAL SKILLS contd

NAMES OF STUDENTS

KEY 0 No evidence of the skill 1 Is beginning to use the skill 2 Has good use of the skill 3 Can teach someone else the skill															
8. Share ideas															
9. Organize group activities															
10. Behave politely															
11.															
12.															
13.															
14.															
15.															

MOTIVATIONAL SKILLS

NAMES OF STUDENTS

KEY 0 No evidence of the skill 1 Is beginning to use the skill 2 Has good use of the skill 3 Can teach someone else the skill															
1. Plan for doing homework															
2. Do homework															
3. Turn in homework															
4. Organize															
5. Do the best I can															
6. Enjoy making things															
7. Enjoy ideas															
8. Enjoy planning															

MOTIVATIONAL SKILLS contd

NAMES OF STUDENTS

KEY 0 No evidence of the skill 1 Is beginning to use the skill 2 Has good use of the skill 3 Can teach someone else the skill															
9. Enjoy working independently															
10. Want to do better															
11.															
12.															
13.															
14.															
15.															
16.															

DASH

Name________________________

Date________________________

STUDENT PAGE 4.1.10
DASH FOURTH GRADE CONCEPT AND SKILL INVENTORY

CONCEPTS:

There are four possible responses to each of the following entries:

0 I have no understanding of the concept.
1 I am beginning to understand the concept.
2 I have good understanding of the concept.
3 I can teach someone else to understand the concept.

Circle ONE response.

	UNDERSTANDING			
CONCEPTS	No	Beginning	Good	Teach
1. Cloud types	0	1	2	3
2. Weather maps	0	1	2	3
3. Weather fronts	0	1	2	3
4. Wind chill	0	1	2	3
5. Lightning	0	1	2	3
6. Gnomon	0	1	2	3
7. Zodiacal Band	0	1	2	3
8. Planet	0	1	2	3
9. Constellation	0	1	2	3

Name ______________________

	UNDERSTANDING			
CONCEPTS contd	**No**	**Beginning**	**Good**	**Teach**
10. Standard time	0	1	2	3
11. Latitude	0	1	2	3
12. Sundial	0	1	2	3
13. Seasons	0	1	2	3
14. Greenwich	0	1	2	3
15. Incubation	0	1	2	3
16. Embryology	0	1	2	3
17. Reproduction	0	1	2	3
18. Animal growth	0	1	2	3
19. Animal development	0	1	2	3
20. Animal behavior	0	1	2	3
21. Digestive system	0	1	2	3
22. Food Pyramid system	0	1	2	3
23. Respiratory system	0	1	2	3
24. Digestion	0	1	2	3
25. Anatomy	0	1	2	3
26. Migration	0	1	2	3
27. Hibernation	0	1	2	3
28. Annual plants	0	1	2	3

Name ______________________

CONCEPTS contd	UNDERSTANDING No	 Beginning	 Good	 Teach
29. Perennial plants	0	1	2	3
30. Fungus	0	1	2	3
31. Nutrients	0	1	2	3
32. Force	0	1	2	3
33. Streamlining	0	1	2	3
34. Energy	0	1	2	3
35. Friction	0	1	2	3
36. Speed	0	1	2	3
37. Hardness	0	1	2	3
38. Specific gravity	0	1	2	3
39. Clay	0	1	2	3
40. Fire safety	0	1	2	3
41. Linear measure	0	1	2	3
42. Area measure	0	1	2	3
43. Volume measure	0	1	2	3
44. Mass measure	0	1	2	3
45. Gases	0	1	2	3
46. Liquids	0	1	2	3
47. Solids	0	1	2	3

SP 4.1.10—4

Name ______________________

CONCEPTS contd	UNDERSTANDING No	 Beginning	 Good	 Teach
48. Science	0	1	2	3
49. Technology	0	1	2	3
50.	0	1	2	3
51.	0	1	2	3
52.	0	1	2	3
53.	0	1	2	3
54.	0	1	2	3
55.	0	1	2	3
56.	0	1	2	3
57.	0	1	2	3
58.	0	1	2	3
59.	0	1	2	3
60.	0	1	2	3
61.	0	1	2	3
62.	0	1	2	3
63.	0	1	2	3
64.	0	1	2	3
65.	0	1	2	3
66.	0	1	2	3

Name ______________________

MECHANICAL/INTELLECTUAL SKILLS

There are four possible responses to each of the following entries:

0 I have no use of the skill.
1 I am beginning to use the skill.
2 I have good use of the skill.
3 I can teach someone else the skill.

Circle ONE response.

	PERFORMANCE			
MECHANICAL/ INTELLECTUAL SKILLS	No	Beginning	Good	Teach
1. Divide a distance into 10 equal parts	0	1	2	3
2. Make a balance	0	1	2	3
3. Measure area	0	1	2	3
4. Measure mass	0	1	2	3
5. Measure volume	0	1	2	3
6. Measure specific gravity	0	1	2	3
7. Make a hardness scale	0	1	2	3
8. Put out a fire safely	0	1	2	3
9. Make a fire safely	0	1	2	3
10. Determine the height of clouds	0	1	2	3
11. Determine pH	0	1	2	3
12. Preserve food	0	1	2	3
13. Determine latitude	0	1	2	3

Name ______________________

PERFORMANCE

MECHANICAL/ INTELLECTUAL SKILLS contd	No	Beginning	Good	Teach
14. Determine when it's local noon	0	1	2	3
15. Make a sundial	0	1	2	3
16. Identify different cloud types	0	1	2	3
17. Predict weather	0	1	2	3
18. Find the North Star	0	1	2	3
19. Locate planets in the sky	0	1	2	3
20.	0	1	2	3
21.	0	1	2	3
22.	0	1	2	3
23.	0	1	2	3
24.	0	1	2	3
25.	0	1	2	3
26.	0	1	2	3
27.	0	1	2	3
28.	0	1	2	3
29.	0	1	2	3
30.	0	1	2	3
31.	0	1	2	3

Name ______________________

INTERPERSONAL SKILLS:

There are four possible responses to each of the following entries:

0 I have no use of the skill.
1 I am beginning to use the skill.
2 I have good use of the skill.
3 I can teach someone else the skill.

Circle ONE response.

	PERFORMANCE			
INTERPERSONAL SKILLS	No	Beginning	Good	Teach
1. Carry out responsibilities	0	1	2	3
2. Share things	0	1	2	3
3. Wait my turn	0	1	2	3
4. Have patience with others	0	1	2	3
5. Help others	0	1	2	3
6. Work in groups	0	1	2	3
7. Lead in groups	0	1	2	3
8. Share ideas	0	1	2	3
9. Organize group activities	0	1	2	3
10. Behave politely	0	1	2	3
11.	0	1	2	3
12.	0	1	2	3

Name ______________________

MOTIVATIONAL SKILLS

There are four possible responses to each of the following entries:

0 I have no use of the skill.
1 I am beginning to use the skill.
2 I have good use of the skill.
3 I can teach someone else the skill.

Circle ONE response.

	PERFORMANCE			
MOTIVATIONAL SKILLS	No	Beginning	Good	Teach
1. Plan for doing homework	0	1	2	3
2. Do homework	0	1	2	3
3. Turn in homework	0	1	2	3
4. Organize	0	1	2	3
5. Do the best I can	0	1	2	3
6. Enjoy making things	0	1	2	3
7. Enjoy ideas	0	1	2	3
8. Enjoy planning	0	1	2	3
9. Enjoy working independently	0	1	2	3
10. Want to do better	0	1	2	3
11.	0	1	2	3
12.	0	1	2	3

DASH

Name________________________

Date________________________

STUDENT PAGE 4.1.1 THE LEARNING CALENDAR

Make a list of uses for the Learning Calendar.

1. ____

____

2. ____

____

3. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

Name________________________

Date________________________

DASH

STUDENT PAGE 4.1.2 PERSONAL RESPONSIBILITY CHART

Complete the chart below.

DATE TO DO	RESPONSIBILITY	DATE DONE

DASH

Name______________________

Date_______________________

STUDENT PAGE 4.1.3 LAST YEAR

List new questions for the Wonder and Discover Book.

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____
7. ____

DASH

Name____________________

Date____________________

STUDENT PAGE 4.1.4 LIBRARY CARD

Author ________________

Number ________________

Date ________________

Description

Figure SP 4.1.4 Example of a library card

Name____________________________

Date____________________________

STUDENT PAGE 4.1.5A WORKING TOGETHER

REASONS FOR WORKING IN A GROUP	REASONS FOR WORKING INDEPENDENTLY

SP 4.1.5B GROUP AND INDEPENDENT TASKS

Name ____________________

Date ____________________

Complete the table below. Use a check mark ( ) to indicate whether the task should be done in a group or independently.

TASK TO BE CARRIED OUT	IN A GROUP	INDEPENDENTLY	REASON FOR CHOICE OF METHOD

DASH

Name________________________

Date________________________

STUDENT PAGE 4.1.6A GOALS FOR THE FIRST SEMESTER

List your goals for the first semester. At the end of the semester, use the rating scales below to evaluate your achievement by circling the number that best describes your progress.

ABILITY	PRACTICE
1. I cannot yet do what my goal calls for.	1. I do not do what my goal calls for.
2. I can do what my goal calls for.	2. I sometimes do what my goal calls for.
3. I can do what my goal calls for and teach it to someone else.	3. I usually or always do what my goal calls for.

GOALS FOR THE FIRST SEMESTER

WHAT TO DO FOR MYSELF AND OTHERS	MIDYEAR RATING					
	ABILITY			PRACTICE		
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3

BEST COPY AVAILABLE

DASH

Name________________________

Date________________________

STUDENT PAGE 4.1.6B GOALS FOR THE SECOND SEMESTER

List your goals for the second semester. At the end of the school year, use the rating scales below to evaluate your achievement by circling the number that best describes your progress.

ABILITY	PRACTICE
1. I cannot yet do what my goal calls for.	1. I do not do what my goal calls for.
2. I can do what my goal calls for.	2. I sometimes do what my goal calls for.
3. I can do what my goal calls for and teach it to someone else.	3. I usually or always do what my goal calls for.

GOALS FOR THE FIRST SEMESTER

WHAT TO DO FOR MYSELF AND OTHERS	END-OF-YEAR RATING					
	ABILITY			PRACTICE		
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3

BEST COPY AVAILABLE

DASH

Name________________________

Date________________________

STUDENT PAGE 4.1.6C GOALS FOR THE SUMMER

List your goals for the summer. At the end of the summer, use the rating scales below to evaluate your achievement by circling the number that best describes your progress.

ABILITY	PRACTICE
1. I cannot yet do what my goal calls for.	1. I do not do what my goal calls for.
2. I can do what my goal calls for.	2. I sometimes do what my goal calls for.
3. I can do what my goal calls for and teach it to someone else.	3. I usually or always do what my goal calls for.

GOALS FOR THE FIRST SEMESTER

WHAT TO DO FOR MYSELF AND OTHERS	END-OF-SUMMER RATING					
	ABILITY			PRACTICE		
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3
	1	2	3	1	2	3

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Name____________________________

Date____________________________

DASH

STUDENT PAGE 4.1.7 APHORISMS TO LIVE BY

Fill in an aphorism for each concept.

SOME APHORISMS TO LIVE BY

	CONCEPTS	APHORISMS
1.	Eat adequate and appropriate food.	
2.	Go slow on sugar, fat, and salt.	
3.	Get eight hours of sleep.	
4.	Replace the water you lose each day by drinking adequate amounts of liquid (6–8 glasses of water).	
5.	Wash your hands *before* eating or handling food and *after* using the toilet.	
6.	Keep your lips in the water and off the fountain.	

Name ______________________

7.	Attend to tooth care. Brush 20 times up and 20 down. Don't forget to floss.	
8.	Attend to skin and hair care.	
9.	Wear clothes suitable for the weather and time of day.	
10.	Make regular use of the toilet.	
11.	Make your environment safe and clean.	
12.	Seek help in treating wounds.	
13.	When sick, stay away from others.	
14.	Cover your nose and mouth when sneezing and coughing.	
15.	Share with those about you.	
16.	Remember your responsibilities and carry them out.	

Name ____________________

17.	Plan ahead.	
18.	Help those who need help.	
19.	Know the emergency phone number.	
20.	Play a fair game.	
21.	Put things away when you're finished.	
22.	Treat all living things with respect.	
23.	Exercise 20–30 minutes a day.	
24.	Stay away from alcohol, tobacco, and recreational drugs.	
25.	If you really know and understand something, you can teach it.	

Name____________________________

Date____________________________

STUDENT PAGE 4.1.8 PERSONAL PLANNING CALENDAR

Complete the table below.

DATE DUE	HOMEWORK/EVENT	DATE COMPLETED

DASH

Name___________________

Date___________________

STUDENT PAGE 4.1.9 SURVIVAL GAME

1. Record the date of the council. ___________

2. Explain how you arrived at the date.

3. Record how much time there will be before the onset of fall weather. _____________

4. Explain how you made your determination.

5. List the basic biological needs that must be satisfied in order to survive.

6. List the six most pressing needs listed above. Put them in order according to how long we can survive without attending to them.

1. ____________ 4. ____________

2. ____________ 5. ____________

3. ____________ 6. ____________

7. Below is a list of the things that your teacher can lead you to learn about. List them in the order in which you should learn them.
   - The ways to the seasons, weather, and the sky.
   - The ways of birds and other animals.
   - The ways of plants.
   - Food that nourishes you.
   - Good rock for working.
   - Ways to work rock.
   - Ways to fashion boats and capture the wind.
   - Ways of the hunt.
   - The mysteries of fire.
   - The making of pottery.
   - How to raise and understand animals.
   - Ways to measure and equally divide the things around us.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________
11. ______________________________
12. ______________________________

Name____________________

Date____________________

DASH

STUDENT PAGE 4.1.10
DASH FOURTH GRADE CONCEPT AND SKILL INVENTORY

CONCEPTS:

There are four possible responses to each of the following entries:

0 I have no understanding of the concept.
1 I am beginning to understand the concept.
2 I have good understanding of the concept.
3 I can teach someone else to understand the concept.

Circle ONE response.

	UNDERSTANDING			
CONCEPTS	No	Beginning	Good	Teach
1. Cloud types	0	1	2	3
2. Weather maps	0	1	2	3
3. Weather fronts	0	1	2	3
4. Wind chill	0	1	2	3
5. Lightning	0	1	2	3
6. Gnomon	0	1	2	3
7. Zodiacal Band	0	1	2	3
8. Planet	0	1	2	3
9. Constellation	0	1	2	3

SP 4.1.10—2

Name ______________________

		UNDERSTANDING		
CONCEPTS contd	No	Beginning	Good	Teach
10. Standard time	0	1	2	3
11. Latitude	0	1	2	3
12. Sundial	0	1	2	3
13. Seasons	0	1	2	3
14. Greenwich	0	1	2	3
15. Incubation	0	1	2	3
16. Embryology	0	1	2	3
17. Reproduction	0	1	2	3
18. Animal growth	0	1	2	3
19. Animal development	0	1	2	3
20. Animal behavior	0	1	2	3
21. Digestive system	0	1	2	3
22. Food Pyramid system	0	1	2	3
23. Respiratory system	0	1	2	3
24. Digestion	0	1	2	3
25. Anatomy	0	1	2	3
26. Migration	0	1	2	3
27. Hibernation	0	1	2	3
28. Annual plants	0	1	2	3

SP 4.1.10—3

Name ______________________

CONCEPTS contd	UNDERSTANDING No	 Beginning	 Good	 Teach
29. Perennial plants	0	1	2	3
30. Fungus	0	1	2	3
31. Nutrients	0	1	2	3
32. Force	0	1	2	3
33. Streamlining	0	1	2	3
34. Energy	0	1	2	3
35. Friction	0	1	2	3
36. Speed	0	1	2	3
37. Hardness	0	1	2	3
38. Specific gravity	0	1	2	3
39. Clay	0	1	2	3
40. Fire safety	0	1	2	3
41. Linear measure	0	1	2	3
42. Area measure	0	1	2	3
43. Volume measure	0	1	2	3
44. Mass measure	0	1	2	3
45. Gases	0	1	2	3
46. Liquids	0	1	2	3
47. Solids	0	1	2	3

Name ____________________

	UNDERSTANDING			
CONCEPTS contd	**No**	**Beginning**	**Good**	**Teach**
48. Science	0	1	2	3
49. Technology	0	1	2	3
50.	0	1	2	3
51.	0	1	2	3
52.	0	1	2	3
53.	0	1	2	3
54.	0	1	2	3
55.	0	1	2	3
56.	0	1	2	3
57.	0	1	2	3
58.	0	1	2	3
59.	0	1	2	3
60.	0	1	2	3
61.	0	1	2	3
62.	0	1	2	3
63.	0	1	2	3
64.	0	1	2	3
65.	0	1	2	3
66.	0	1	2	3

Name ____________________

MECHANICAL/INTELLECTUAL SKILLS

There are four possible responses to each of the following entries:

0 I have no use of the skill.
1 I am beginning to use the skill.
2 I have good use of the skill.
3 I can teach someone else the skill.

Circle ONE response.

MECHANICAL/ INTELLECTUAL SKILLS	PERFORMANCE No	 Beginning	 Good	 Teach
1. Divide a distance into 10 equal parts	0	1	2	3
2. Make a balance	0	1	2	3
3. Measure area	0	1	2	3
4. Measure mass	0	1	2	3
5. Measure volume	0	1	2	3
6. Measure specific gravity	0	1	2	3
7. Make a hardness scale	0	1	2	3
8. Put out a fire safely	0	1	2	3
9. Make a fire safely	0	1	2	3
10. Determine the height of clouds	0	1	2	3
11. Determine pH	0	1	2	3
12. Preserve food	0	1	2	3
13. Determine latitude	0	1	2	3

Name ______________________

	PERFORMANCE			
MECHANICAL/ INTELLECTUAL SKILLS contd	**No**	**Beginning**	**Good**	**Teach**
14. Determine when it's local noon	0	1	2	3
15. Make a sundial	0	1	2	3
16. Identify different cloud types	0	1	2	3
17. Predict weather	0	1	2	3
18. Find the North Star	0	1	2	3
19. Locate planets in the sky	0	1	2	3
20.	0	1	2	3
21.	0	1	2	3
22.	0	1	2	3
23.	0	1	2	3
24.	0	1	2	3
25.	0	1	2	3
26.	0	1	2	3
27.	0	1	2	3
28.	0	1	2	3
29.	0	1	2	3
30.	0	1	2	3
31.	0	1	2	3

Name ____________________

INTERPERSONAL SKILLS:

There are four possible responses to each of the following entries:

0 I have no use of the skill.
1 I am beginning to use the skill.
2 I have good use of the skill.
3 I can teach someone else the skill.

Circle ONE response.

	PERFORMANCE			
INTERPERSONAL SKILLS	No	Beginning	Good	Teach
1. Carry out responsibilities	0	1	2	3
2. Share things	0	1	2	3
3. Wait my turn	0	1	2	3
4. Have patience with others	0	1	2	3
5. Help others	0	1	2	3
6. Work in groups	0	1	2	3
7. Lead in groups	0	1	2	3
8. Share ideas	0	1	2	3
9. Organize group activities	0	1	2	3
10. Behave politely	0	1	2	3
11.	0	1	2	3
12.	0	1	2	3

Name ______________________

MOTIVATIONAL SKILLS

There are four possible responses to each of the following entries:

0 I have no use of the skill.
1 I am beginning to use the skill.
2 I have good use of the skill.
3 I can teach someone else the skill.

Circle ONE response.

	PERFORMANCE			
MOTIVATIONAL SKILLS	No	Beginning	Good	Teach
1. Plan for doing homework	0	1	2	3
2. Do homework	0	1	2	3
3. Turn in homework	0	1	2	3
4. Organize	0	1	2	3
5. Do the best I can	0	1	2	3
6. Enjoy making things	0	1	2	3
7. Enjoy ideas	0	1	2	3
8. Enjoy planning	0	1	2	3
9. Enjoy working independently	0	1	2	3
10. Want to do better	0	1	2	3
11.	0	1	2	3
12.	0	1	2	3

DASH

GRADE FOUR
CLUSTER 2

Time, Weather, and Sky

4.2.1 Rainfall
4.2.2 Snowfall
4.2.3 Wind Direction
4.2.4 Wind Speed
4.2.5 Height of Clouds
4.2.6 Humidity
4.2.7 Clouds and Weather
4.2.8 Storm Clouds
4.2.9 Lightning
4.2.10 Weather Maps
4.2.11 Weather Fronts
4.2.12 Predicting Weather
4.2.13 Wind Chill
4.2.14 Flat or Round Earth?
4.2.15 Length of Day and Night
4.2.16 The Sun's Shadow Path
4.2.17 Planetarium
4.2.18 Using the Planetarium
4.2.19 Planets
4.2.20 When Is It Noon?
4.2.21 Making a Sundial
4.2.22 Using a Sundial
4.2.23 Seasons and the Sun
4.2.24 Moon Phases and the Sun
4.2.25 Eclipses

ACTIVITY 4.2.1 RAINFALL

OBJECTIVES

The students
- Find a way to measure rainfall.
- Invent and refine rain gauges.
- Set up a system for recording rainfall.

BACKGROUND

This activity continues the five-year study of precipitation started in grade 2. Here the students measure rainfall by using rain gauges.

What Rain Gauges Measure

Rain gauges measure how deep the water would stand on flat ground after a rain if none of it seeped into the ground or ran off into depressions, sewers, and rivers. Depth is reported in inches and centimeters. Though any container can be used to catch and measure rainfall, one with straight vertical sides, including the mouth, gives results that can be read directly without need for adjustment. See Figure 4.2.1.

Finding Good Gauges

It is a good idea to put containers of various shapes out in a rainstorm and then compare the depths of water they collect. The containers should be placed in the same open area. Normally containers with straight sides from the mouth down to their base will collect about the same depth of water. For example, a soup can, a coffee can, and a rectangular aquarium will all collect the same depth of rain. Tapered or irregular-sided containers will collect variable depths. Straight-sided containers will collect a greater depth of rain than small-mouthed containers such as soda bottles. Tapered large-mouthed containers such as plastic cups will collect a greater depth of water than straight-sided containers. Tin cans or milk cartons make good rain gauges. If a milk carton is used, the top should be reinforced with a piece of wire bent into a square, and the carton should be replaced as it becomes waterlogged.

Vandalism

If vandalism is a problem at school, have the students arrange to gather rainfall information at home. It will be interesting to observe how homes very close to each other will receive different amounts of rain. If data from several home stations are used, the idea of averaging should emerge from discussion.

STUDENT ROLES

Meteorologist
Inventor

MATERIALS

Tin cans or milk cartons
Pliers
Coat hanger wire
Other containers for comparison
Metric rulers
Student Pages 4.2.1A RAINFALL
4.2.1B PRECIPITATION RECORD

PRODUCTS

Rain gauges
Completed Student Pages

PROCEDURES

1. **Review the students' previous work with collecting rain data and explain that this year we will try to predict when rain and snow will fall and how much there will be. For this we need a way to measure rainfall and snowfall. For snowfall measurement, see Activity 4.2.2 SNOWFALL.**

   Ask such questions as
   - What do we measure when we measure rainfall? (Get at the idea that we measure the depth of the water that has fallen on an area over some period of time.)
   - How do we measure the amount of rainfall? Can you show us in a diagram?
   - When we measure rain, why doesn't the same depth of water stand on the ground that stands in a rain gauge? (Get at the idea of runoff and seepage into the ground.)
   - Where should we place a rain gauge to get a good measure of the amount of rain that has fallen? (Work to the idea that gauges

under trees and next to buildings do not always catch all the rain that falls.)
- How can we still collect data if vandalism is a problem? (Get at the idea of home stations.)

2. **Have student groups design and make rain gauges. Have them use Student Page 4.2.1A RAINFALL to describe their work.**

   Ask such questions as
   - What are the advantages of having the walls of the gauge straight rather than tapered or irregular? (If there are questions, have the students test the effects of tapering and irregularity in the first rain.)
   - Which design will produce the gauge easiest to read? Why?
   - Which design will provide the most durable gauge? Why?

3. **Help the students set up procedures for recording rainfall and tending the gauges. Have them begin their data collection using Student Page 4.2.1B PRECIPITATION RECORD for recording.**

   Ask such questions as
   - Should the gauge be read at the same time each day? Why? (So the times of rainfall can be compared.)
   - Should we empty the gauge after we read it? Why? (Get at the idea of measuring each period from a zero-level starting point. If water is left in a gauge, part of it will evaporate. If the next rain is a week later, we won't know the starting level.)
   - What units of measure should we use to record depth? Why? (Rain and snow should be measured in the same units—inches or centimeters or both.)
   - Why do we need to record findings on a regular basis whether we think it has rained or not? (There may have been rain we don't know about.)
   - Why do we need to check the condition of the gauge regularly? (Work to such ideas as gauges can collect debris, become rusty, leak, and so forth.)

4. **When the students begin to predict weather, have them start to predict the amount of precipitation that will fall and test their predictions.**

Ask such questions as

- How close were your predictions to the amounts measured?
- On what basis did you make your prediction?

EXTENSIONS

Have the students

- Set up gauges at home to compare readings with those made at school.
- Visit a weather station and compare its rain gauges with the ones used in school. Ask them to discuss how the gauges are alike or different.

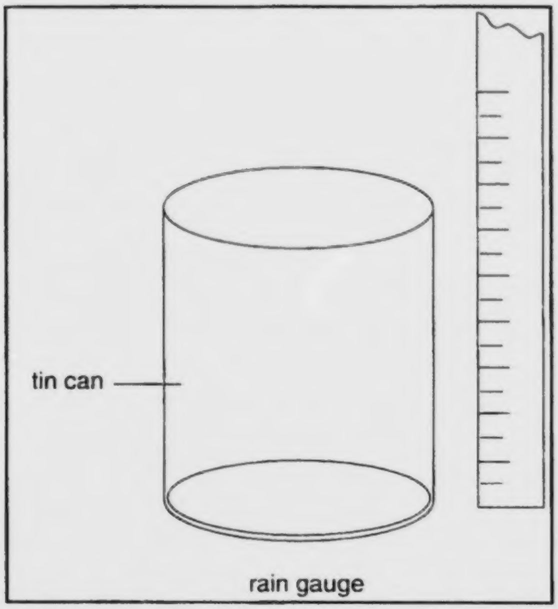


Figure 4.2.1 Rain gauge

DASH

Name________________________

Date________________________

STUDENT PAGE 4.2.1A RAINFALL

1. Draw and label a diagram of your rain gauge.

2. Explain how your rain gauge works.

____

____

____

____

____

____

____

____

DASH

STUDENT PAGE 4.2.1B
PRECIPITATION RECORD

Name ____________________

Date ____________________

MONTH ________ YEAR______

DATE	1	2	3	4	5	6	7	8	9	10	11	TOTALS	
Snowfall (cm)													▨
Snow water (cm)												▨	
Rainwater (cm)												▨	
DATE	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**			
Snowfall (cm)											▨		▨
Snow water (cm)											▨	▨	
Rainwater (cm)											▨	▨	
DATE	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**			
Snowfall (cm)											▨		▨
Snow water (cm)											▨	▨	
Rainwater (cm)											▨	▨	
							Total snowfall (cm)						▨
							Total water (cm)					▨	

ACTIVITY 4.2.2 SNOWFALL

OBJECTIVES

The students
- Find a way to measure snowfall.
- Invent and refine snow gauges.
- Set up a system to record snowfall.

BACKGROUND

This activity continues the DASH study of precipitation started in grade 2. Here the students devise ways of measuring snowfall. Measurement of snowfall may be less precise than measurement of rain because snow can pile up or be blown away by the wind. Some students may have had previous experience with snow and be aware of some of the problems.

Measuring Snow Depth

One technique for measuring the depth of snowfall is to thrust a stick through the snow until it reaches the ground. A container can then be filled to the same level with snow and the snow can be melted to find the amount of liquid water it produces.

Another technique is to let snow fall on a flat board, measure the snow's depth, and push a can into it as one would a cookie cutter. The board can then be turned over and the snow left in the can to melt so that the liquid water can be measured and compared. See Figure 4.2.2.

Have the students record both the depth of the snow and the equivalent amount of liquid water on Student Page 4.2.1B PRECIPITATION RECORD.

STUDENT ROLES

Meteorologist
Inventor

MATERIALS

Plywood, 12" x 12" or larger
Tin cans
Metric ruler
Meterstick

Student Pages 4.2.1B PRECIPITATION RECORD
4.2.2 SNOWFALL

PRODUCTS

Snow gauges
Learning Calendar record
Completed Student Pages

PROCEDURES

1. **Review the students' previous experience in collecting snowfall data and explain that this year we will try to predict when snow will fall and how much there will be.**

   Ask such questions as
   - What do we measure when we measure the depth of snowfall? (Get at the idea that we measure the depth of the snow that has fallen on an area in a given period of time. This is similar to measuring the depth of rainfall.)
   - How can we measure the amount of snowfall? Can you show us in a diagram?
   - Are there problems in measuring the amount of snow that has fallen? (Get at the idea that snow can melt or blow away.)
   - Where are good places to measure the depth of snow? Why? (Recall that measurements made under trees and next to buildings may give unusual measurements.)
   - How can we find the depth of the liquid water in the snow? (Work to the idea of melting the snow in the gauge and measuring the depth of the liquid water.)

2. **Have the students design snow gauges that can measure both the depth of the snow and the depth of the liquid water produced.**

   Ask such questions as
   - What measurements do we need to make? (Get agreement that we need to measure the depth of fallen snow and the depth of the liquid water produced.)
   - Which gauge should give the most accurate measurement?
   - Which gauge should be the easiest to use?
   - Which gauge should give us a measurement most quickly?

3. **Have the students use Student Page 4.2.1B PRECIPITATION RECORD to record their data.**

4. **Before an expected snowstorm, have the students predict how much snow will fall and have them set up their gauges.**

   After measurement, ask such questions as
   - How close were your predictions?
   - How did you make your predictions?
   - How might you make better predictions the next time?
   - Why should we read the gauge at the same time each day?
   - Why do we need to record both the depth of the snow and the amount of liquid water left when the snow melts? (This can lead to the research question of whether below the same volume of snow always produces the same amount of liquid water. Testing will show fairly wide differences.)

5. **Have the students pursue their own questions about measurement of snowfall.**

   Such questions might include
   - How are we going to make separate measurements for each day when it snows for several days in a row? How do we know where the last measured snow ends and the new begins? (Explore such things as placing a board over the previous snow or subtracting its depth from the total snowfall.)
   - How are we going to measure the snowfall if some of the snow melts and then it starts snowing again? (Discuss such things as measuring when it stops snowing before the snow begins to melt.)
   - Does the same volume of snow always produce the same amount of liquid water?
   - What happens to the volume of snow when it stands on the ground for several days? (Have the students research such ideas as the wind may fluff it, it may be compressed, or some may evaporate.)
   - Do equal volumes of snow taken at the bottom, middle, and top of a snow pile produce the same amount of liquid water? Why? (Get at such ideas as snow at the bottom of a pile will probably be more compressed and therefore will produce more liquid water per unit of volume.)

6. **Have the students use Student Page 4.2.2 SNOWFALL to report their research.**

EXTENSION

- Have the students visit a weather station find out how meteorologists measure snowfall.

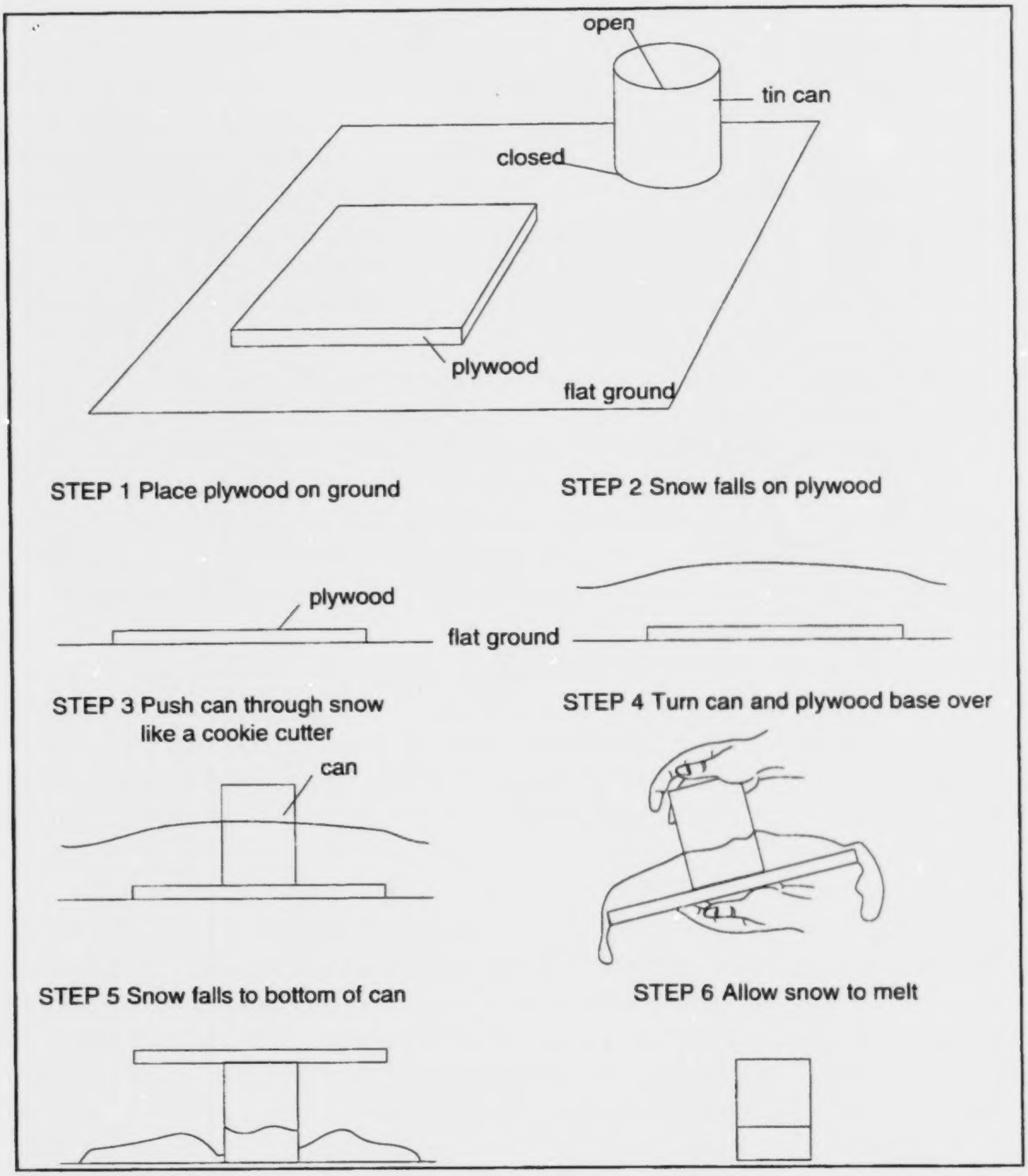

open
tin can
closed
plywood
flat ground
STEP 1 Place plywood on ground
STEP 2 Snow falls on plywood
plywood
flat ground
STEP 3 Push can through snow like a cookie cutter
can
STEP 4 Turn can and plywood base over
STEP 5 Snow falls to bottom of can
STEP 6 Allow snow to melt

Figure 4.2.2 Snow gauge

BEST COPY AVAILABLE

DASH

Name________________________

Date________________________

STUDENT PAGE 4.2.2 SNOWFALL

1. Draw and label a diagram of a snow gauge.

2. Explain how the snow gauge works.

3. State your research questions and how you collected your data. Record your data and give your interpretation.

ACTIVITY 4.2.3 WIND DIRECTION

OBJECTIVES

The students
- Review their previous work with wind direction.
- Set up a wind station.
- Establish procedures for data collection.
- Investigate problems concerning wind.

BACKGROUND

Because DASH students have been collecting data on wind direction since kindergarten, they should already have expertise in setting up a wind direction station and interpreting the significance of wind direction information. It is suggested that the cloth or plastic wind direction indicator used in previous years again be used because it is less responsive to minor changes in wind direction than the more classical wind vane. See Figure 4.2.3(1). It may be worthwhile to mark the points of the compass around some permanent post that can be used to tether the indicator. For information on compass construction, see Figures 4.2.3(2–4).

Using a Compass

Review how to use a compass, particularly how to find true north. Students in Hawai'i and Washington will find it about 25 degrees west of magnetic north while those in Louisiana will find it 5 degrees west of magnetic north. However, students in Florida and Alabama will find that true north and magnetic north just about coincide. Students in Pennsylvania and North Carolina will find true north about 5 degrees east of magnetic north. For further discussion, see Activity 4.2.20 WHEN IS IT NOON?

The students should be reminded to review their previous work on the effect of buildings and trees on wind direction before they select their tethering site.

STUDENT ROLE

Meteorologist

MATERIALS

Cloth or plastic for wind direction indicators
Commercial magnetic compass or a cork, nail, magnet, and nonmetallic bowl
Student Page 4.2.3 WIND DIRECTION

PRODUCTS

Wind direction indicators
Student investigations
Completed Student Pages

PROCEDURES

1. **Help the students review previous work with wind direction.**

   Ask such questions as
   - What do we mean by wind direction? (Get at the idea of the direction the wind is coming from.)
   - In what direction does the wind indicator float when it is used to find wind direction? (Work to the idea that it floats in the direction the wind is going.)
   - In what direction does the tethered end point? (In the direction that the wind is coming from.)
   - What do we mean by "prevailing" wind? (The direction that the wind comes from most of the time.)
   - How do we record the wind's direction? (In compass readings.)

2. **Have the students set up their wind station.**

   In preparation, ask such questions as
   - Where should we set up our wind direction station?
   - Should we set up our station next to the building? Under a tree? Why? (Get at the idea that wind changes its direction when it hits big objects such as trees and buildings. If there is uncertainty, have the students test this.)
   - How can we permanently establish compass points? (Discuss marking the area to identify compass points.)

3. **Have the students choose their procedures for collecting data and start their collecting.**

4. **Help the students investigate their own questions about wind.**

Such questions might include
- Does the wind usually come from a particular direction when it is about to rain?
- Does the wind usually come from a particular direction when it is about to snow?
- What are the conditions when the wind starts to change direction?
- When does the wind seem to be strong?
- When does the wind seem to be light?
- One method of telling the wind direction is to wet a finger and hold it up to see which side dries first. How accurate is this method compared to the wind indicator method?

5. **Have the students report on their investigations.**

EXTENSIONS

Have the students
- Make other kinds of wind direction indicators and compare them with the indicator used by the class.
- List the kinds of industries that need to have information on wind direction and why they need it.
- Find out how wind direction is determined at a weather station and how it is recorded.

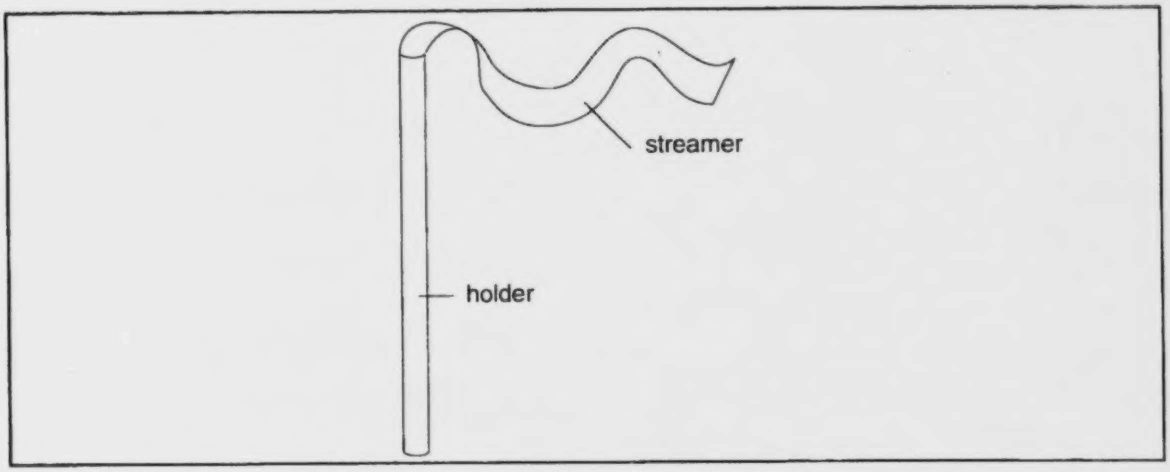
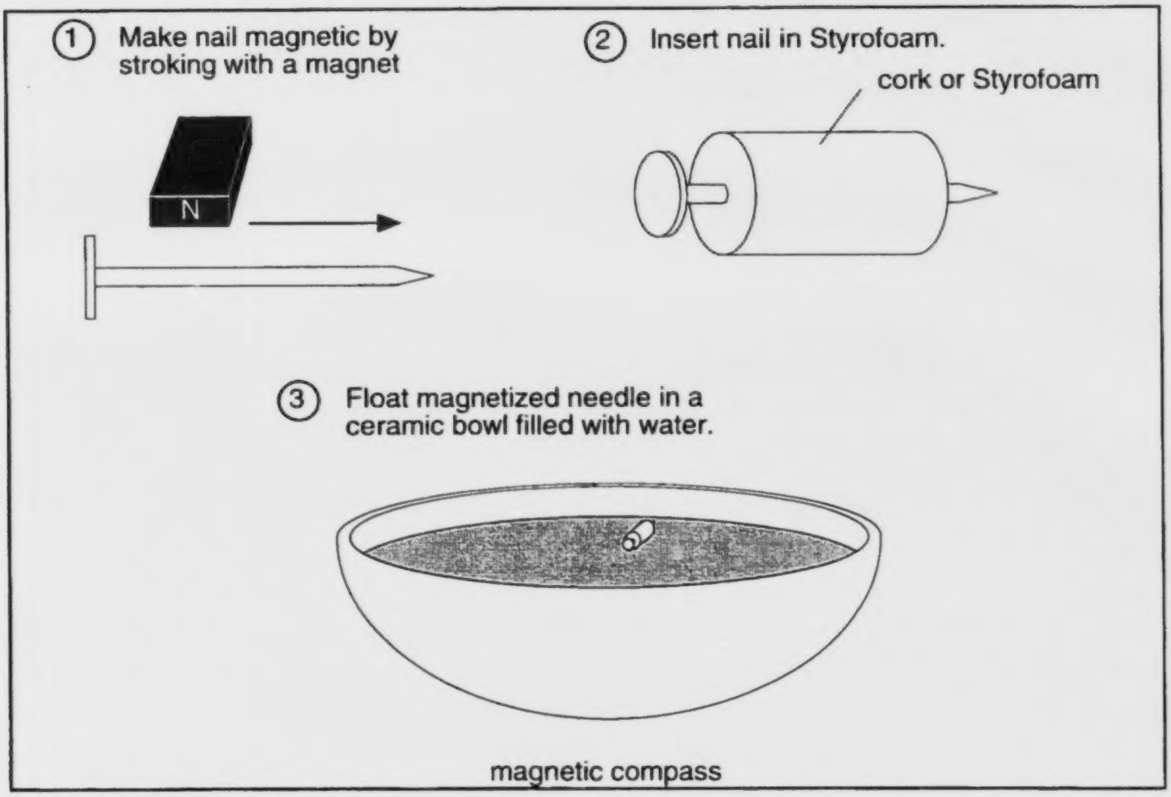

streamer
holder

Figure 4.2.3(1) Wind direction indicator


① Make nail magnetic by stroking with a magnet

② Insert nail in Styrofoam.

③ Float magnetized needle in a ceramic bowl filled with water.

N
cork or Styrofoam
magnetic compass

Figure 4.2.3(2) Making a magnetic compass

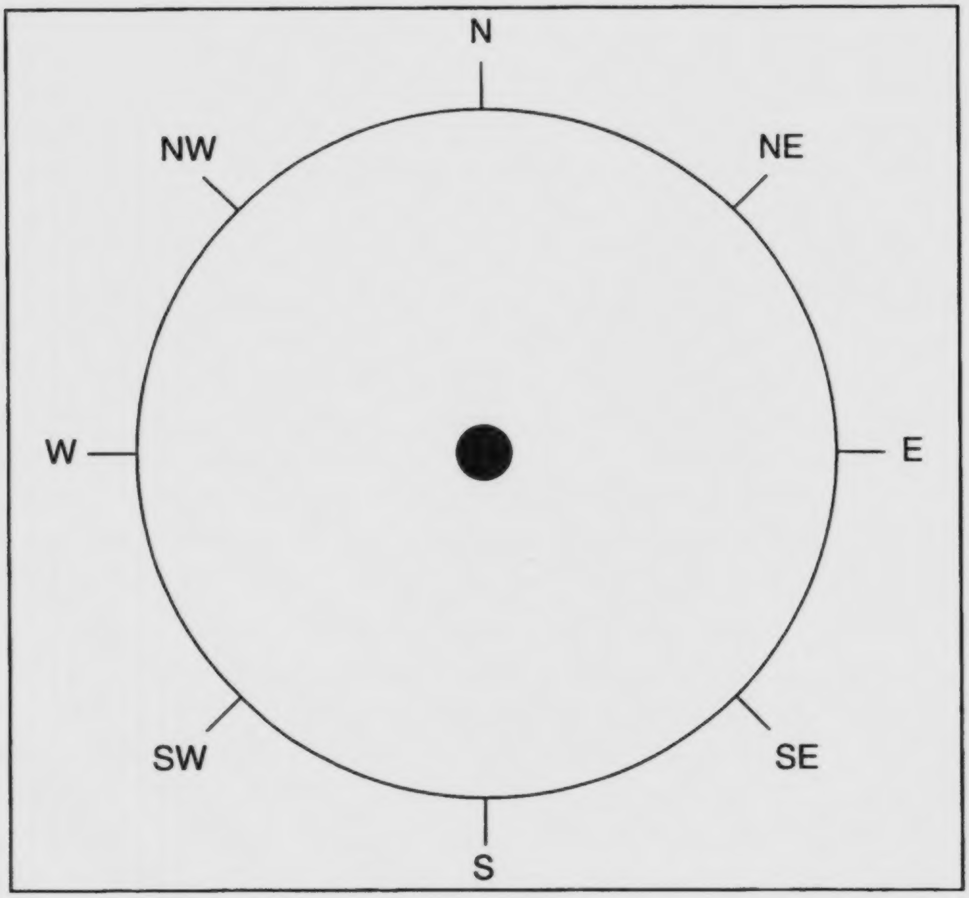

N
NW
NE
W
E
SW
SE
S

Figure 4.2.3(3) Template for a compass card

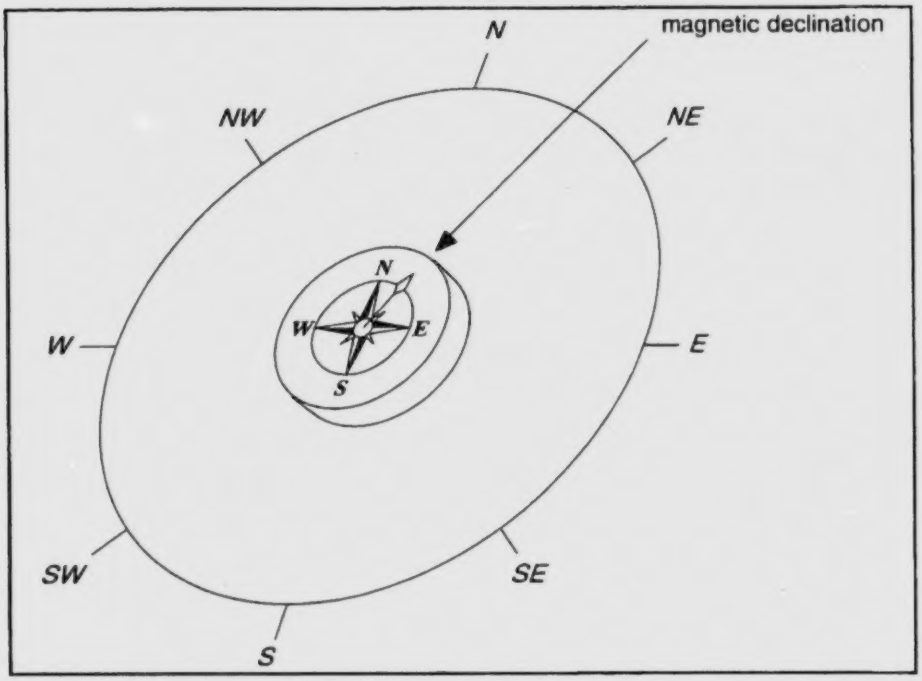

magnetic declination
N
NW
NE
W
E
SW
SE
S
N
W
E
S

Figure 4.2.3(4) Orienting the compass card using a magnetic compass with correction for magnetic declination

DASH

Name________________________

Date________________________

STUDENT PAGE 4.2.3 WIND DIRECTION

1. Draw and label a diagram of your wind direction indicator and explain how it works.

____

____

____

____

2. State your research question. Tell how you collected your data and how you interpreted it.

____

____

____

____

____

____

____

ACTIVITY 4.2.4 WIND SPEED

OBJECTIVES

The students
- Review wind speed.
- Practice making wind speed observations.
- Set up recording procedures.
- Investigate their own questions about wind speed.

BACKGROUND

DASH students have been collecting information on wind speed since grade 2. They have been using the Beaufort wind scale which provides a way of estimating ranges of wind speed from observations of what the wind does to things in the environment. The scale shown in Student Page 4.2.4A is a refinement of the one used in grades 2 and 3.

STUDENT ROLE

Meteorologist

MATERIALS

Student Pages	4.2.4A BEAUFORT SCALE 4.2.4B WIND SPEED

PRODUCTS

Completed Student Pages

PROCEDURES

1. Review previous work with wind speed.

Ask such questions as
- What is wind? (Work toward the idea that wind is moving air.)
- How can we show that wind is something? (Help the students recall that things occupy space. Have them demonstrate that air occupies space. This can be done by pushing a clear jar or plastic cup, bottom up, into a container of water. Air will be trapped, occupying the space and keeping water from entering.)

- What do we mean by wind speed? (Get at the idea of how fast a gust of wind moves.)
- How have we estimated wind speed before? (Help the students recall using the Beaufort scale.)
- Why is wind important to us? (Get at such things as it can operate windmills, it moves clouds, it cools us, and so forth.)

2. **Introduce the Beaufort scale to determine wind speed.**

   Have the students
   - Review each of the Beaufort descriptions.
   - Practice using the Beaufort scale to estimate wind speed for several weeks if needed.

3. **Set up recording procedures to report wind speed.**

4. **Have the students investigate their own questions about wind speed.**

   Such questions as the following might be explored:
   - Are there places in the path of a wind gust where the wind moves faster than in other places?
   - How could we measure the speed of a wind more precisely?
   - How could we see the wind to measure its speed?

5. **Have the students make daily observations and record their data on the Learning Calendar.**

EXTENSIONS

Have the students
- Visit a weather station and compare the way wind speed is measured there with the way they have been measuring it.
- Check their ability to estimate wind speed with that of the instruments used at a weather station.
- Keep track of the kinds of wind damage reported in the papers. Have them record the speed of the wind when it causes different kinds of damage.
- Report on things people should do to protect themselves in very high winds.

DASH

Name__________________________

Date__________________________

STUDENT PAGE 4.2.4A BEAUFORT SCALE

Scale No.	Miles/ hour	Km/ Hour	Indicators	Kind of Wind
0	.0 to 0.9	.0 to 1.5	Smoke goes straight up	Calm
1	1.0 to 3.9	1.6 to 6.5	Smoke drifts sideways	Light air
2	4.0 to 7.9	6.6 to 12.5	Leaves rustle	Slight breeze
3	8.0 to 12.9	12.6 to 20.5	Leaves and twigs move	Gentle breeze
4	13.0 to 18.9	20.6 to 30.5	Small branches move; dust, paper fly	Moderate breeze
5	19.0 to 24.9	30.6 to 40.5	Water ripples; small trees sway	Fresh breeze
6	25.0 to 31.9	40.6 to 51.5	Large branches move	Strong breeze
7	32.0 to 38.9	51.6 to 62.5	Trunks of trees bend; walking difficult	High wind
8	39.0 to 46.9	62.6 to 75.5	Twigs break off	Gale
9	47.0 to 54.9	75.6 to 87.5	Shingles carried away	Strong gale
10	55.0 to 63.9	87.6 to 104.5	Trees uprooted	Whole gale
11	64.0 to 72.9	104.6 to 116.7	Widespread damage	Windstorm
12	73.0 to	116.6 to	General disaster	Hurricane Tornado

Name________________________

Date________________________

DASH

STUDENT PAGE 4.2.4B WIND SPEED

1. List your questions about wind speed.

2. Give answers to your questions and explain how you got them.

ACTIVITY 4.2.5 HEIGHT OF CLOUDS

OBJECTIVES

The students
- Estimate the altitude range of clouds.
- Use triangulation in estimating altitude.

BACKGROUND

This is the first activity in a series on clouds and weather. It should be followed by 4.2.7 CLOUDS AND WEATHER, 4.2.8 STORM CLOUDS, 4.2.9 LIGHTNING, 4.2.10 WEATHER MAPS, and 4.2.11 WEATHER FRONTS. In HEIGHT OF CLOUDS the students are given a triangulation method that uses an altitude table to estimate the height of clouds. Estimating the height of tops of clouds is a first step in identifying clouds and predicting weather.

Demonstration

A logic for the technique can be investigated by folding a 90° corner of a sheet of paper in half. The resulting triangle will have angles of 45°, 45°, and 90°. Cut out this triangle and fold one short side over on the other. These two overlapping sides will be found to be the same length. The new triangle will be another 45°/45°/90° triangle only half the size of the first. The folding process can be repeated, and the two short sides of any 45°/45°/90° triangle will always be found to be equal. It follows that a 45°/45°/90° triangle with a base of 3 km will have an altitude of 3 km. At the root of this process is the geometric principle that the sides of triangles with equal angles are always equal.

Cloud Ranges

Different kinds of clouds are found in three altitude ranges or zones. Low-level clouds are considered to be those whose tops are anywhere from sea level to roughly 3 km or about 2 miles; mid-range, with tops anywhere from 3 km to roughly 7 km, or about 4.5 miles; and high-range, with tops from 7 km on.

Fist Method of Angle Estimation

For quick field work, use the arc made by piling fists one upon another upward through 90°. Start with the bottom of the first fist lined up with the unobstructed horizon. Then pile fists one upon another until the top fist or some part of it lines up with the top of the cloud. Count fractions of a fist in fingers. The number of fists needed to make an angle of 90° is nine for most people. A fist equals about 10°; a finger, 2°. A 45° angle is four and a half fists; a 66° angle, six fists and three fingers. See Figure 4.2.5.

Making Altitude Estimates

Find landmarks of known approximate distances from where the students will stand when making their sightings. Student Page 4.2.5 gives a diagram for estimating cloud height above landmarks 3 km or 1.8 miles away. Clouds with tops below four and a half fists are low; with tops between four and a half and six and a half, medium; with tops above six and a half, high. This system gives good estimates for schools from 0 to 2000 feet (0–660 m) above sea level.

- Wait until a cloud is above the landmark and estimate the angle between the horizon and the cloud's top.
- Refer to the student page to see what altitude range the cloud's top is within.
- When there is an overcast sky, estimate the height of the base of the cloud blanket. See Student Pages 4.2.8A LAYERED AND HEAPED CLOUDS and 4.2.8B COMBINATION AND PRECIPITATING CLOUDS for diagrams showing the heights of bases of different clouds.
- For each additional 1000 feet (330 m) a school is above sea level, reduce the angle by 4° or 2 fingers.
    - At 0–2000 feet (0–660 m) use 45° as a low-range limit and 66° as a mid-range limit.
    - At 2001–3000 feet (661 m–1000 m) use 41° as a low-range limit and 62° as a mid-range limit.
    - At 3001-4000 feet (1001–1330 m) use 37° and 58° as limits.

View Planes

HEIGHT OF CLOUDS works best where the students have a relatively open view of the horizon in some direction. Ideally, the students should be able to see landmarks about 3 km away. This distance gives good estimates of low-, mid-, and upper-range clouds.

Hills or Buildings Obstructing the Horizon

Use the same procedure as outlined but start fist measurements when looking straight ahead where the horizon would be if the hill or building were not present.

STUDENT ROLE

Meteorologist

MATERIALS

Local map
Student Page 4.2.5 ALTITUDE TABLE WITH LANDMARK AT 3 KM

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Present the problem of estimating how high the tops and bottoms of clouds are above the ground.**

   Ask such questions as
   - How high above the ground do you think clouds usually are? (They are usually 0 to 10 or more kilometers, or 0 to 6 or more miles.)
   - Have you ever seen clouds on the ground? What did they look like? (Fog.)
   - Have you ever been in a cloud? What was it like? (Fog.)
   - Where was the cloud?

2. **Explain that to estimate the height of the tops and bases of clouds we will look for places about 3 km or about 2 miles away. We will estimate how high clouds are above these places.**

   Ask such questions as
   - Where on our school ground can we see buildings and other landmarks off in the distance?
   - Does anyone know a place that is about 3 km (or 2 miles) away from the campus?
   - How do you know that it is about 3 km (or 2 miles) away?
   - How can we be sure a place is that far away? (Work to the idea of using a map and compass.)

3. **Give the students a map of the area and have them find places that are 3 km (about 2 miles) away.**

   Ask such questions as
   - How did you find a place that is 3 km away from your viewpoint on your map? (Get at the idea of using the scale found on the map.)

- Can you find all the places that are 3 km away? (Work to the idea of using a compass to draw a circle that is scaled to 3 km or 2 miles.)

4. **Indicate that now we know where to look, we can find how high the clouds are above points 3 km away.**

Tell the students that to do this we must know the angles between the horizon and the bottom and the horizon and the top of the cloud. To determine these angles, we will use the arc made by our arms and count the number of fists between the horizon and the bottom of the cloud and the horizon and the top of the cloud.

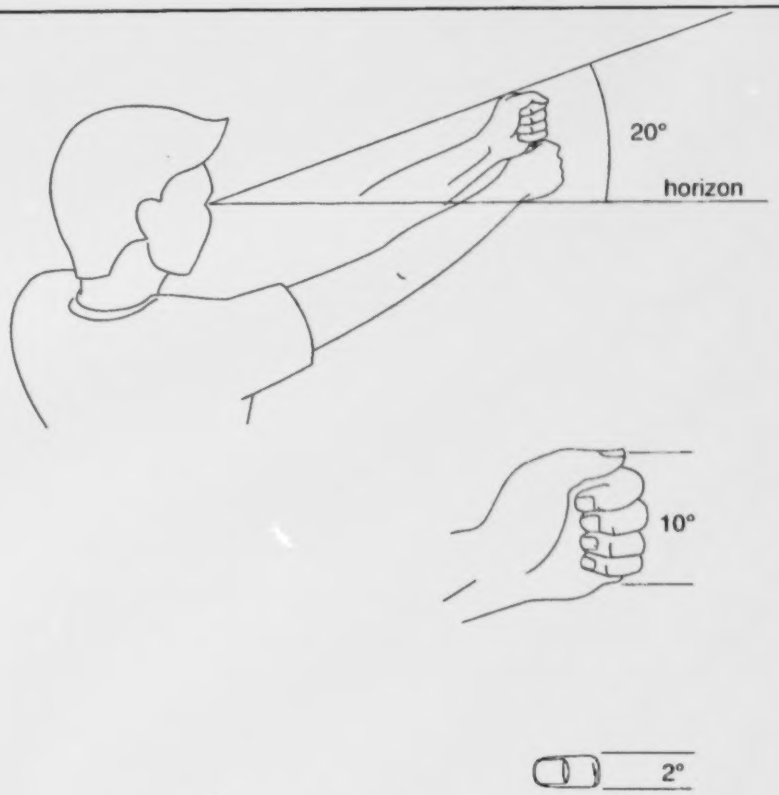
Have the students
- Lie on the floor while grasping a piece of chalk in their fist while they mark a half-circle.
- Mark the center of the circle as the point where the upper arm is attached to the shoulder.
- Mark the arc opposite an angle of 90°.
- Count the number of fists in this arc. (There will be about 9.)
- Determine the number of fists in half of this arc. The arc opposite an angle of 45° will have about 4 and a half fists.)
- Determine the number of fists in the arc opposite an angle of about 60°. (There will be about 6.)

5. **Have the students go outside and use Student Page 4.2.5 ALTITUDE TABLE WITH LANDMARK AT 3 KM to determine the relative height of clouds. See corrections in the Background for schools 2000 feet or more above sea level.**

Have them
- Use a map to locate one or more places about 3 km away.
- Count the number of fists between the horizon and the bottom and the horizon and the top of the cloud when it is above the place chosen to make their estimate.
- Note that clouds 3 km away with tops below 45° are in the low range, those with tops between 45° and 66° are in the mid-range, and those with tops above 66° are in the high range.
- Record the estimated height range and compare their data.
- Make several estimates of the height of different clouds until there is general agreement as to altitude range.

EXTENSION

- Have the students find a location for sighting at home and measure the height of clouds.



Sight along the horizon line with the bottom of your fist. The top of your fist is 10° above the horizon. Each fist represents an additional 10°, each finger 2°.

Figure 4.2.5 The fist method of estimating angles

DASH

Name__________________________

Date__________________________

STUDENT PAGE 4.2.5
ALTITUDE TABLE WITH LANDMARK AT 3 KM

Fill in the missing data

High Clouds

Above 7 km
Above 66°

Above __________ fists

Middle Clouds

3-7 km
between 45° and 66°

Between __________ and
fists

Low Clouds

1-3 km
up to 45°

Up to __________ fists

Object at eye level __________

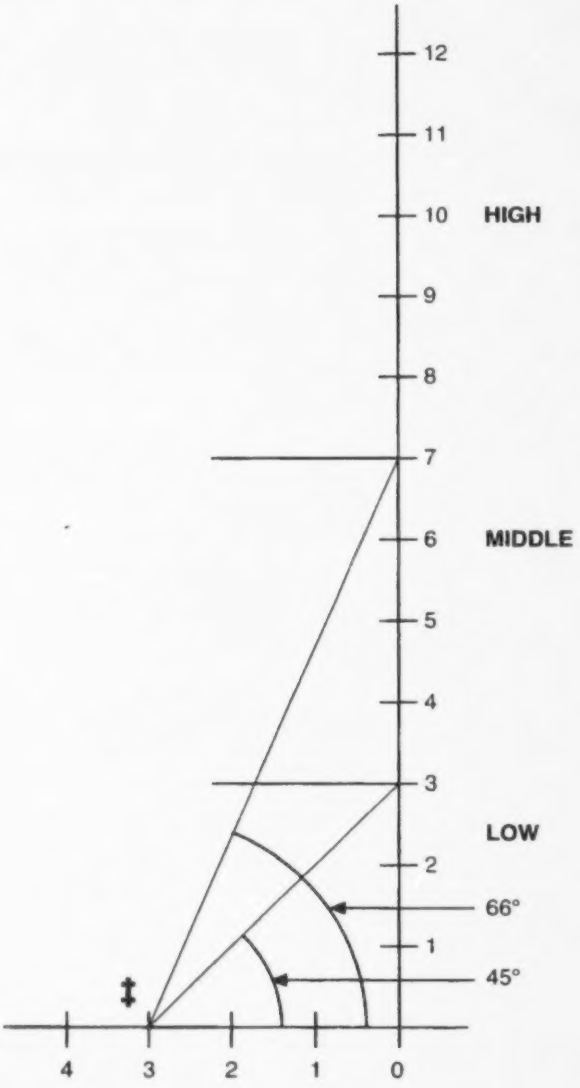

12
11
10
HIGH
9
8
7
6
MIDDLE
5
4
3
LOW
2
66°
1
45°
4
3
2
1
0

Figure SP 4.2.5 Altitude table with landmark at 3 km

ACTIVITY 4.2.6 HUMIDITY

OBJECTIVES

The students
- Make daily observations of humidity.
- Invent a humidity-measuring device.
- Relate humidity to personal comfort.

BACKGROUND

DASH students begin the study of humidity in grade 3. This activity continues observations of the conditions surrounding high and low humidity. The students should suggest observations relating personal comfort and humidity.

Approach

Because the students use cobalt chloride paper as an indicator of the presence of water, they need to invent a protective container for a strip of it. The container might be a plastic bag with holes or a jar with holes in the lid. When the paper is blue, the air is dry; when it is pink, the air is very humid; and when it is purple, the air is mildly humid.

Standardizing

Have the students standardize the colors of their paper using the data from DASH 5 classes where humidity is being measured with a hygrometer. Newspaper reports can be used as an alternative source of humidity data.

"Dry or Sticky" Chart

Along with their humidity data the students keep a "Dry or Sticky" chart showing how the weather feels to them. The chart should show whether the weather feels hot and sticky, comfortable or uncomfortable, and so forth.

STUDENT ROLES

Inventor
Meteorologist

MATERIALS

Crayons
Cobalt chloride paper
Small jar with lid
Plastic bag
Working Dictionary
Student Page 4.2.6 HUMIDITY

PRODUCTS

Humidity data
Completed Student Pages

PROCEDURES

1. **Have the students make a concept map of the term "humidity."**

   Help them include such things as
   - Moisture.
   - Evaporation.
   - Cobalt chloride paper.
   - Sticky and dry.
   - High and low.
   - Comfort and discomfort.

2. **Review the color changes of cobalt chloride paper and have the students invent a way to protect a strip of the humidity indicator from hand dirt and dust.**

3. **Establish procedures for measuring humidity.**

   Have them
   - Invent a way to standardize the color range of the humidity indicator. (They should be able to get at least three readings—high, middle, and low, and, over time, five readings with the ranges between middle-low and middle-high identified.)
   - Invent a way to record the color spectrum for their range. (Crayons or wide-spectrum commercial paint chips might be used.)

  - Invent a way of standardizing their class standard with other measures of humidity. (The students can use newspaper reports, fifth grade data, and so forth.)
  - Determine where and when they are going to make their measurements.
  - Keep a Dry or Sticky chart to be posted with their humidity reports.

4. **Have the students summarize their data at the end of the year.**

   Ask such questions as
   - What was the humidity right before, during, and right after a rain or snow?
   - What, if any, connection is there between our sense of stickiness and humidity?
   - What are the high-humidity seasons?

EXTENSION

- Have the students report on how the U.S. National Weather Service measures humidity.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.2.6 HUMIDITY

1. Explain how the class made its humidity gauge.

2. Explain how the humidity gauge works.

3. Explain how humidity seems to be related to comfort.

ACTIVITY 4.2.7 CLOUDS AND WEATHER

OBJECTIVES

The students
- Observe and describe fair-weather clouds.

BACKGROUND

A major theme throughout DASH is weather. In grade 4 the students begin to work with clouds, weather maps, and weather fronts. CLOUDS AND WEATHER is the second in the series on cloud study. It should come after Activity 4.2.5 HEIGHT OF CLOUDS and be followed by Activities 4.2.8 STORM CLOUDS, 4.2.9 LIGHTNING, 4.2.10 WEATHER MAPS, 4.2.11 WEATHER FRONTS, and 4.2.12 PREDICTING WEATHER.

The students observe clouds during a period of predicted fair weather. They need to record the shape, color, size, and height of the clouds. They also need to establish a working definition of the term **fair weather**, which means generally bright and sunshiny.

Though knowing the names of clouds is not essential to the activity, names help in thinking about clouds. At the beginning of the last century, 1803, the Englishman Luke Howard identified two basic groups of clouds—those that are **heaped**, called **cumulus clouds**, and those that are **layered**, called **stratus clouds**. Table 4.2.7 adds two more groups—clouds that are a **combination of heaped and layered clouds** and **precipitating clouds.** For diagrams of clouds see Student Pages 4.2.8A and 4.2.8B.

Table 4.2.7 Types of clouds

	TYPE OF CLOUD			
ALTITUDE OF TOPS	**LAYERED**	**HEAPED**	**COMBINATION**	**PRECIPITATING**
HIGH Above 7 km	Cirrostratus	Cumulonimbus (nonprecipitating)	Cirrocumulus	Cumulonimbus (precipitating) Cirrus
MIDDLE Between 3 km & 6 km	Altostratus	Swelling cumulus	Altocumulus (nonprecipitating)	Altocumulus (precipitating)
LOW Below 3 km	Stratus Fog	Cumulus	Stratocumulus	Nimbostratus

Cloud Ranges

In classifying clouds we also need to know their altitude range. The tops of low-range clouds are found between sea level and 3 km, or about 2 miles; the tops of middle-range clouds between 3 km and 7 km, or about 4.5 miles; and the tops of high-range clouds above 7 km.

Fair-Weather Clouds

Common fair-weather clouds are

- **Cumulus**—small fluffy, low-level clouds with bottoms and tops in the low range.
- **Swelling cumulus**—clouds with bottoms in the low range and tops in the middle range. They are taller-than-wide single clouds with dynamically moving cauliflower-like tops.

STUDENT ROLE

Meteorologist

MATERIALS

Student Pages	4.2.5 ALTITUDE TABLE 4.2.7 FAIR-WEATHER CLOUDS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **When the newspaper predicts fair weather for several days, have the students observe the clouds that pass over a sighting landmark. Have them draw the clouds on Student Page 4.2.7 FAIR-WEATHER CLOUDS and describe the clouds and the conditions they observed.**

Help the students include such things as
- Shape.
- Color.
- Height of bottom and top of the cloud.
- Direction of movement.
- Temperature.
- Date.
- Time.
- Size.

2. **Make reports of fair-weather and other clouds part of the ongoing collection of Learning Calendar data. Give the students the names "cumulus" and "swelling cumulus," common fair-weather clouds.**

3. **Have the students make generalizations about their findings.**

Ask such questions as
- What is meant by "fair" weather?
- What are the common features of fair-weather clouds?
- What are the occasional features of fair-weather clouds?

EXTENSIONS

Have the students
- Make a board display of pictures and drawings of fair-weather clouds.
- Research and report on fair-weather clouds.

DASH

STUDENT PAGE 4.2.7 FAIR-WEATHER CLOUDS

Name ____________________

Date ____________________

DATE	TIME	TEMP °C	COLOR	COLOR	HT	DRAWING	MOVEMENT DIRECTION

ACTIVITY 4.2.8 STORM CLOUDS

OBJECTIVES

The students
- Observe and describe storm clouds.
- Associate clouds with their formal names.

BACKGROUND

This activity introduces the study of storm clouds. A major theme throughout DASH is weather. This activity is the third in the series on cloud study. It should come after 4.2.5 HEIGHT OF CLOUDS and 4.2.7 CLOUDS AND WEATHER and should be done concurrently with 4.2.9 LIGHTNING. It should be followed by 4.2.11 WEATHER FRONTS.

Approach

In STORM CLOUDS the students observe clouds before and during storms. They need to record the shape, color, size, height, and other characteristics of storm clouds, and they need to establish a working definition of the term **storm,** which usually involves general sunlessness, wind, and precipitation. The students watch the changes in weather from fair to increasingly cloudy and stormy.

Common Storm Clouds

Typical storm clouds include those listed below.
- **Nimbostratus clouds** are precipitating low-level layered clouds. They are thick dark-gray clouds with ragged edges.
- **Cumulonimbus clouds** are of two types—precipitating and nonprecipitating. Both are towering clouds extending from the low range up through the high range (below 3 km to above 7 km). Because of their dynamic nature, cumulonimbus clouds may be nonprecipitating one moment and precipitating the next. Storms that they generate are usually short-lived but often violent.

Less Common Storm Clouds

Below are some less common producers of precipitation:
- **Altocumulus clouds,** like cumulonimbus clouds, may or may not produce precipitation. When they do produce precipitation, it is usually light and spotty.

- **Cirrus clouds** are composed of ice crystals. Because they are formed at great height, these crystals seldom reach the ground. They usually evaporate as they fall.

STUDENT ROLE

Meteorologist

MATERIALS

Student Pages	4.2.8A LAYERED AND HEAPED CLOUDS 4.2.8B COMBINATION AND PRECIPITATING CLOUDS 4.2.8C STORM CLOUDS

PRODUCTS

Learning Calendar records
Completed Student Pages

PROCEDURES

1. **Start a storm watch when the paper predicts stormy weather. Have the students describe clouds that pass over a sighting landmark and make sightings several times during the day.**

   Have them use Student Page 4.2.8C STORM CLOUDS to draw and describe the clouds they see in terms of
   - Shape.
   - Color.
   - Size (description).
   - Height to the top of the cloud.
   - Direction of cloud movement.
   - Date.
   - Time.
   - Outside temperature.
   - Presence of lightning.
   - Other distinctive features.

2. **Make the storm watch part of the ongoing weather observations reported on the Learning Calendar. Have the students use Student Pages 4.2.8A–B for the names and characteristics of clouds.**

3. Help the students generalize their findings.

Ask such questions as
- What is meant by stormy weather?
- What are the common features of storm clouds?
- What are the occasional features of storm clouds?
- What are the temperature changes and wind conditions that accompany stormy weather?

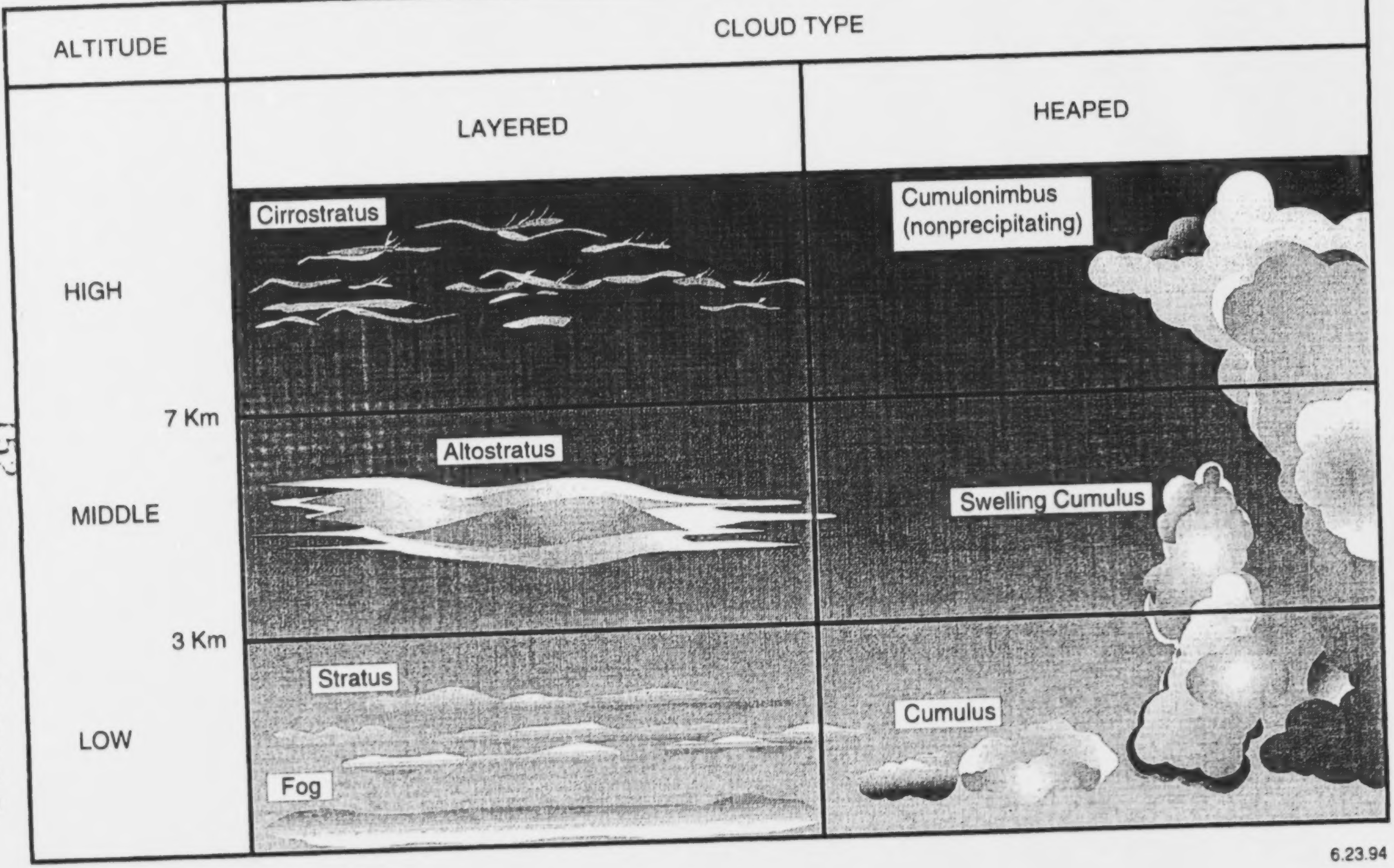
EXTENSIONS

Have the students
- Establish a board display of pictures and drawings of storm clouds.
- Make a research report on storm clouds.

SP 4.2.8A LAYERED AND HEAPED CLOUDS

Name ____________________

Date ____________________


ALTITUDE
CLOUD TYPE
LAYERED
HEAPED
HIGH
7 Km
MIDDLE
3 Km
LOW
Cirrostratus
Cumulonimbus (nonprecipitating)
Altostratus
Swelling Cumulus
Stratus
Fog
Cumulus

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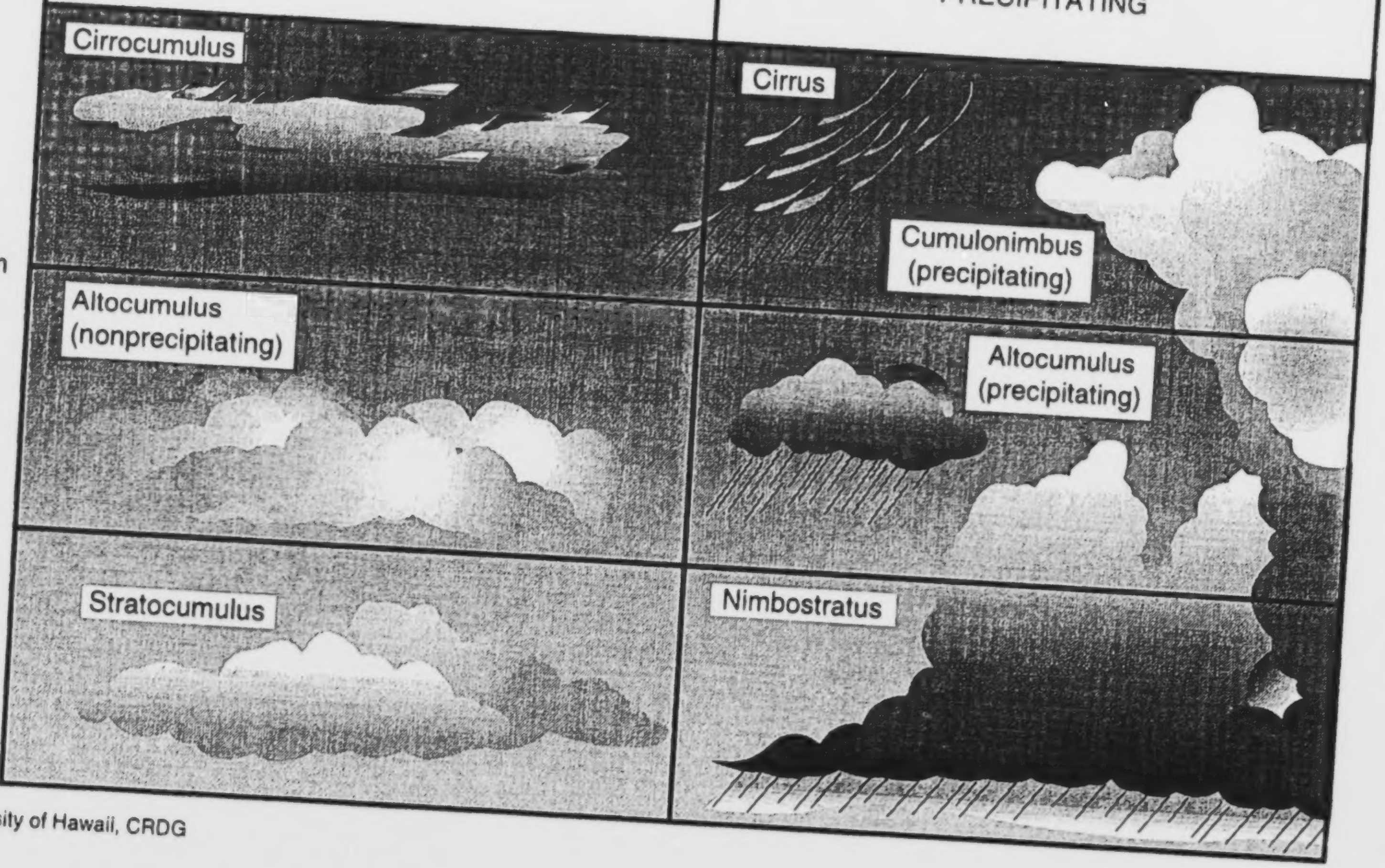
SP 4.2.8B COMBINATION AND PRECIPITATING CLOUDS

Name ______________________

Date ______________________

ALTITUDE	CLOUD TYPE	
	COMBINATION	PRECIPITATING
HIGH		
7 Km		
MIDDLE		
3 Km		
LOW		


Cirrocumulus
Cirrus
Cumulonimbus (precipitating)
Altocumulus (nonprecipitating)
Altocumulus (precipitating)
Stratocumulus
Nimbostratus

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STUDENT PAGE 4.2.8C STORM CLOUDS

Name ________________

Date ________________

DATE	TIME	TEMP °C	COLOR	SIZE	DRAWING	HT	MOVEMENT DIRECTION	PRECIPITATION

ACTIVITY 4.2.9 LIGHTNING

OBJECTIVES

The students
- Invent a way to measure the distance between themselves and a lightning strike.
- Observe and describe lightning's characteristics.
- Identify places to avoid in a lightning storm.

BACKGROUND

This activity begins the study of lightning. Lightning is one of the most beautiful, terrifying, and energetic of all natural phenomena. An ordinary 12-volt car battery with an output of 10 amperes can produce a spark of an inch or so, but it takes up to 30,000,000 volts and 200,000 amperes to produce a lightning discharge. The heat produced by lightning may be hotter than the surface of the sun. The power of a single lightning discharge can split a giant tree, set fire to a home, or destroy the electrical circuitry of computers and television sets served by a power line. Despite lightning's great energy, its moment of existence is too short for us to harness its potential for commercial use with our existing technologies.

In this activity the students first learn about lightning safety through an information-giving quiz. They then observe thunderstorms. It is best to run this activity along with 4.2.8 STORM CLOUDS. Don't expect the students to know a great deal about lightning. By discussing the questions in the quiz they will gain the information they will need in the activity.

Calculating the Distance to a Lightning Strike

To calculate the distance to a lightning strike
- Count the number of seconds between sighting a bolt of lightning and hearing its thunder. The students will need to practice counting seconds.
- Divide the number of seconds by 3. The quotient is the number of kilometers away that the lightning was seen. The sound of the thunder travels about 1 kilometer per 3 seconds or about 1 mile per 5 seconds.

If it takes 9 seconds for the sound of thunder to reach your ear, then the strike was 3 kilometers or a little less than 2 miles away.

An alternative technique is to use the formula for distance:

DISTANCE = VELOCITY X TIME

Sound travels at the rate of 1 kilometer/3 seconds. Applying the formula to the problem above,

$$\text{DISTANCE} = \frac{1 \text{ kilometer}}{3 \text{ seconds}} \times 9 \text{ seconds} = 3 \text{ kilometers}$$

STUDENT ROLES

Meteorologist
Safety expert

MATERIALS

Student Page 4.2.9 LIGHTNING QUIZ

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Begin the activity by having the students take the LIGHTNING QUIZ on Student Page 4.2.9. Have them discuss their answers.**

2. **Discuss lightning safety.**

   Ask such questions as
   - Has lightning ever struck near anyone? Can you describe for us what it was like? (Be sensitive to students who may have had a personal tragedy associated with lightning.)
   - Has anyone ever seen a fire set by lightning? Where was this?
   - Has anyone ever seen an object hit by lightning? What happened to the object? (Usually objects that are struck by lightning are burned or torn apart.)
   - Where is lightning most likely to strike? (Point out that lightning seems to strike the highest place around. Use this information to decide where it is most likely to strike.)

- Where might lightning strike on a lake? (A boat, particularly one with a mast that extends above the water level.)
- What might lightning strike in a field? (Fences, trees, high ground, standing animals including humans.)
- Where might lightning strike a house? (TV antenna, chimney, lightning rod, highest spot on the roof.)
- What is a lightning rod? (A metal rod usually placed on a roof and connected to pipes or other metal that conducts the electricity so that it harmlessly enters the ground.)

3. Introduce a way to measure the distance from the students to where lightning strikes.

Have the students

- Practice counting 1001, 1002, 1003, and so forth to 1020 at a rate that is very close to 20 seconds. Each number should take a second to say.
- Note that it takes the sound of thunder 3 seconds to travel a kilometer and 5 seconds to travel a mile. Therefore, we can count 1001, 1002, 1003 (one finger out, 1 km); 1001, 1002, 1003 (two fingers out, 2 km); 1001, 1002, 1003 (three fingers out, 3 km), and so forth).
- Note that a flash of lightning reaches our eye all but instantly. (Light travels at 310,000 kilometers or 186,000 miles per second. That's about 7 times around the equator of Earth in a second, so we can say that we see the lightning at very, very close to the same instant that it cuts through the sky.)
- Have the students work out a method using their newly learned counting skill and knowledge of light and sound to determine how far they are from a lightning strike. (Note that they can also count the number of seconds from the instant they see the lightning to the instant they hear the thunder. Taking the total number of seconds and dividing by 3 seconds per kilometer also gives the distance in kilometers. The number of seconds can also be divided by 5 seconds per mile to give the number of miles.)

4. Have the students observe thunderstorms and make generalizations about them.

Ask such questions as

- Where do the lightning bolts seem to start? (The answers will vary with the storm, but usually they start in the cloud. A small percentage travel in the opposite direction.)

- How many bolts seem to come from a single source? (Usually several.)
- Is precipitation always associated with lightning?
- What kinds of clouds are associated with lightning?

EXTENSIONS

Have the students
- Use Student Page 4.2.9 LIGHTNING QUIZ as a post quiz.
- Write up lightning safety rules.

STUDENT PAGE 4.2.9 THE LIGHTNING QUIZ
ANSWER SHEET

Check all of the statements that correctly complete the statement.

1. Lightning
   - __x__ is a very big electrical spark.
   - _____ travels in a straight line.
   - __x__ kills several hundred people every year in our country.
   - _____ that strikes the ground comes mostly from very high clouds.

2. Thunder
   - _____ is produced when clouds bump together.
   - __x__ is produced when the air is suddenly heated by lightning.
   - _____ is very dangerous if it hits you.
   - __x__ is only noise.

3. Thunderstorms
   - _____ are most common in the winter.
   - __x__ may occur in the clouds and not involve the ground.
   - _____ are most dangerous at night.
   - __x__ are more common in the Rockies, Midwest, and Florida than in other parts of the country.

4. In a thunderstorm it is usually safe to
   - __x__ stay in a car.
   - __x__ be in a concrete and steel building.
   - _____ stand in the middle of a field.
   - __x__ be in an airplane.
   - _____ be in a house without a lightning rod.
   - _____ stay under trees in an open field.

5. Lightning
   - __x__ may be hotter than the surface of the sun.
   - __x__ tends to strike the highest object below the cloud it comes from.
   - _____ can be safely detected by flying a kite into a storm.
   - __x__ can strike a power line and burn out electronic equipment.

Figure 4.2.9 Answer sheet for the Lightning Quiz

DASH

Name_________________________

Date_________________________

STUDENT PAGE 4.2.9 THE LIGHTNING QUIZ

Check all of the statements that correctly complete the statement.

1. Lightning
    _____is a very big electrical spark
    _____travels in a straight line.
    _____kills several hundred people every year in our country.
    _____that strikes the ground comes mostly from very high clouds.
2. Thunder
    _____is produced when clouds bump together.
    _____is produced when the air is suddenly heated by lightning.
    _____is very dangerous if it hits you.
    _____is only noise.
3. Thunderstorms
    _____are most common in the winter.
    _____may occur in the clouds and not involve the ground.
    _____are most dangerous at night.
    _____are more common in the Rockies, Midwest, and Florida than in other parts of the country.
4. In a thunderstorm it is usually safe to
    _____stay in a car.
    _____be in a concrete and steel building.
    _____stand in the middle of a field.
    _____be in an airplane.
    _____be in a house without a lightning rod.
    _____stay under trees in an open field.
5. Lightning
    _____may be hotter than the surface of the sun.
    _____tends to strike the highest object below the cloud from which it comes.
    _____can be safely detected by flying a kite into a storm.
    _____can strike a power line and burn out electronic equipment.

ACTIVITY 4.2.10 WEATHER MAPS

OBJECTIVES

The students
- Review what they have learned about weather prediction.
- Collect weather maps and interpret them.
- Check weather predictions.

BACKGROUND

This activity begins the use and study of weather maps. It should be introduced after the students have started their Learning Calendar and daily collection of data on general weather, wind speed, wind direction, outdoor temperature, and rainfall.

Newspaper Information

In this activity the students interpret the information presented on newspaper weather maps and check the correctness of newspaper predictions. If newspaper predictions are not available, they should use TV weather predictions.

At this point in the evolution of understanding weather, the emphasis should be on the nature of weather fronts (places where warmer and colder air meet) and prediction. This investigation will be continued in DASH 5 and 6 when the nature of high- and low-pressure areas is studied along with other meteorological phenomena. It may be discussed in grade 4, but it need not be emphasized.

High and Low Pressure

If explanation of high- and low-pressure areas is called for, show the students how their mouth can produce **high** and **low pressure.** Have them place a straw in their mouth and blow lightly through it—their mouth is a miniature high-pressure region pushing air out from the straw. Have them then gently draw air into their mouth—their mouth is a low-pressure region. The air in the mouth is under low pressure, and high-pressure air from outside pushes in.

Weather Symbols

The students will find that the darts and half circles on the fronts will point in the direction of the front's movement. A warm front is shown by half circles; a cold front, by darts.

STUDENT ROLE

Meteorologist

MATERIALS

Learning Calendar
Newspaper weather map
Student Page 4.2.10 WEATHER PREDICTIONS

PRODUCTS

Learning Calendar entries
Completed Student Pages

PROCEDURES

1. **Review with the students what they have learned about weather prediction.**

   Ask such questions as
   - Have you ever watched meteorologists on TV?
   - What kinds of things do they refer to when they are talking about weather prediction?
   - Where does their information come from?
   - Have you ever seen a weather map in the newspaper? What does it tell us?

2. **Ask the students to watch a weather broadcast on TV and take note of the kind of things the meteorologist talks about. Have them bring in weather maps from newspapers. You may wish to reproduce sample maps for class use.**

3. **Have the students interpret their newspaper weather maps.**

   Have them
   - Locate on the map approximately where they live.
   - Interpret the symbols used on the map.
   - Identify the different kinds of weather fronts. (Note that fronts are represented on the map by lines of darts and half circles that show the boundaries between different kinds of weather.)
   - Identify the symbols for cold air and warm air.

- Give a hypothesis about the direction in which the darts (cold front) and half circles (warm front) point.
- Devise a way to determine how to interpret where the warm and cold regions are in relation to the half circles and darts. (This can be done after watching a set of fronts move for several days.)
- Identify the temperature lines. (Lines of constant temperature or isotherms.)
- Report what TV meteorologists talked about.

4. Go over the newspaper weather predictions.

Have the students

- Find the prediction for the region of the school.
- Post the prediction on the Learning Calendar on the day for which it is made.
- Add bringing in current weather maps to the daily Responsibility Chart.
- Add checking and reporting on weather predictions to the Responsibility Chart.

5. Follow up the first interpretation of weather maps with daily reports on the weather.

Reports should include

- How the weather has changed over the last several days. (Have the students compare weather maps.)
- Whether the weather prediction for the day was correct and if it was incorrect, what seems to have changed.
- The most recent prediction.
- How many predictions for the month have been correct and how many have been incorrect. See Student Page 4.2.10 WEATHER PREDICTIONS.

EXTENSIONS

- Some newspapers have weekly, monthly, and seasonal predictions. Set up a system to check the accuracy of the predictions.
- In addition to putting the daily weather map on the Learning Calendar, have the students paste another copy on heavy card stock to make a flip book. Have them put the maps in sequence from oldest on top to most recent at the bottom and then flip the maps to watch the progress of storm fronts across the country.

Name________________________

Date________________________

DASH

STUDENT PAGE 4.2.10 WEATHER PREDICTIONS

MONTH/YEAR	WEATHER PREDICTED	CHECK IF CORRECT

ACTIVITY 4.2.11 WEATHER FRONTS

OBJECTIVES

The students
- Observe, describe, and make generalizations about the events occurring along weather fronts.

BACKGROUND

This activity is one of the sequence on weather. It should follow ACTIVITIES 4.2.8 STORM CLOUDS and 4.2.10 WEATHER MAPS and precede 4.2.12 PREDICTING WEATHER. In WEATHER FRONTS the students observe and correlate information on clouds, temperature changes, and wind direction as different kinds of fronts pass over the region of the school.

Have the students use newspaper and TV reports as sources of information. Be sure weather maps from the newspaper are being posted on the Learning Calendar each day.

Do not hurry to give the students information about fronts. They will need considerable experience to interpret events. Weather is often quite fickle, and they will need to observe numerous generations of cold and warm fronts before generalizations will make sense. Remember that DASH students will study weather at even greater depth in grades 5 and 6.

Weather Generalizations

The following kinds of generalizations will emerge with time since weather over the continental United States follows fairly consistent patterns:
- Fronts usually move across the continental United States from west to east.
- Fronts in Hawai'i usually move across the islands from northeast to southwest.
- Storm activity will be found along **fronts**, places where warm and cold air masses come together.
- When a warm-air mass overtakes a cold-air mass, we call the region where they meet a **warm front.** Usually the first observed weather change announcing the coming of a warm front is the appearance of high-level (above 7 km) wispy **cirrus clouds** followed by **cirrostratus** clouds. Because warm air is less dense and often more moist than cold air, it will ride over or above the denser cold-air mass.

As the front progresses, the warm air pushes lower into the middle-altitude range (3–7 km) and **altostratus** clouds form. As warm air pushes into the lower range (below 3 km), **nimbostratus** clouds are likely to form, bringing precipitation. When the front has passed, the temperature rises and cumulus clouds form. Often the air along a front will have little moisture content, and no rain will result.

- When a mass of cold air overtakes a mass of warm air, we call the region where they meet a **cold front**. Usually when a cold front arrives over a place in the continental United States, the wind speed increases and the wind direction changes to south or southwest. A cold front hugs the ground. If there is enough moisture in the warm air, **nimbostratus** or **cumulonimbus** clouds appear on the horizon and shortly produce rain or snow. Where differences in temperature are great, storms along cold fronts can be violent.
- Cold fronts often pass rapidly. Passage is usually indicated by a lowering of the temperature, a reduction of the wind speed, and a wind change to west or northwest. Weather that follows is normally clear.
- For various reasons either warm or cold fronts can become stationary, and the weather may remain unchanged for over a week.

The students are asked to make diagrams showing the order of events in passing fronts and the altitude of the clouds involved. There will be variations particularly in the time dimension because fronts move at different speeds. See Figures 4.2.11(1) and (2) for idealized diagrams of warm and cold fronts.

STUDENT ROLE

Meteorologist

MATERIALS

Learning Calendar information
Student Pages 4.2.8A LAYERED AND HEAPED CLOUDS
4.2.8B COMBINATION AND PRECIPITATING CLOUDS
4.2.11 WEATHER FRONTS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **When the weather maps show approaching warm and cold fronts, have the students collect and correlate information on the passing weather events. Have them use Student Page 4.2.11 WEATHER FRONTS for recording.**

   Have them record the
   - Order in which cloud types appear.
   - Time when various cloud types start to appear in the sky.
   - Direction of the movement of clouds.
   - Wind direction at ground level when different types of clouds are present.
   - Wind speed at ground level when different types of clouds are present.
   - Temperature at ground level when different types of clouds are present.
   - Amount of precipitation that falls, if any.

2. **After each observed passage of a warm or cold front, help the students correlate their information.**

   Ask such questions as
   - What was the order in which the clouds appeared?
   - From which direction did the clouds seem to come?
   - From which direction did the ground wind come?
   - What happened to the speed of the ground wind when the clouds were in the lower altitudes?
   - What happened to the temperature after the front had passed?
   - How much precipitation fell?

3. **On a separate piece of paper have the students make diagrams of front passage similar to those shown in Figures 4.2.11(1) and (2).**

EXTENSION

- Invite a meteorologist to come and talk about weather and fronts. Share the experience so that explanations do not get complicated. Have the students compile their questions ahead of time.

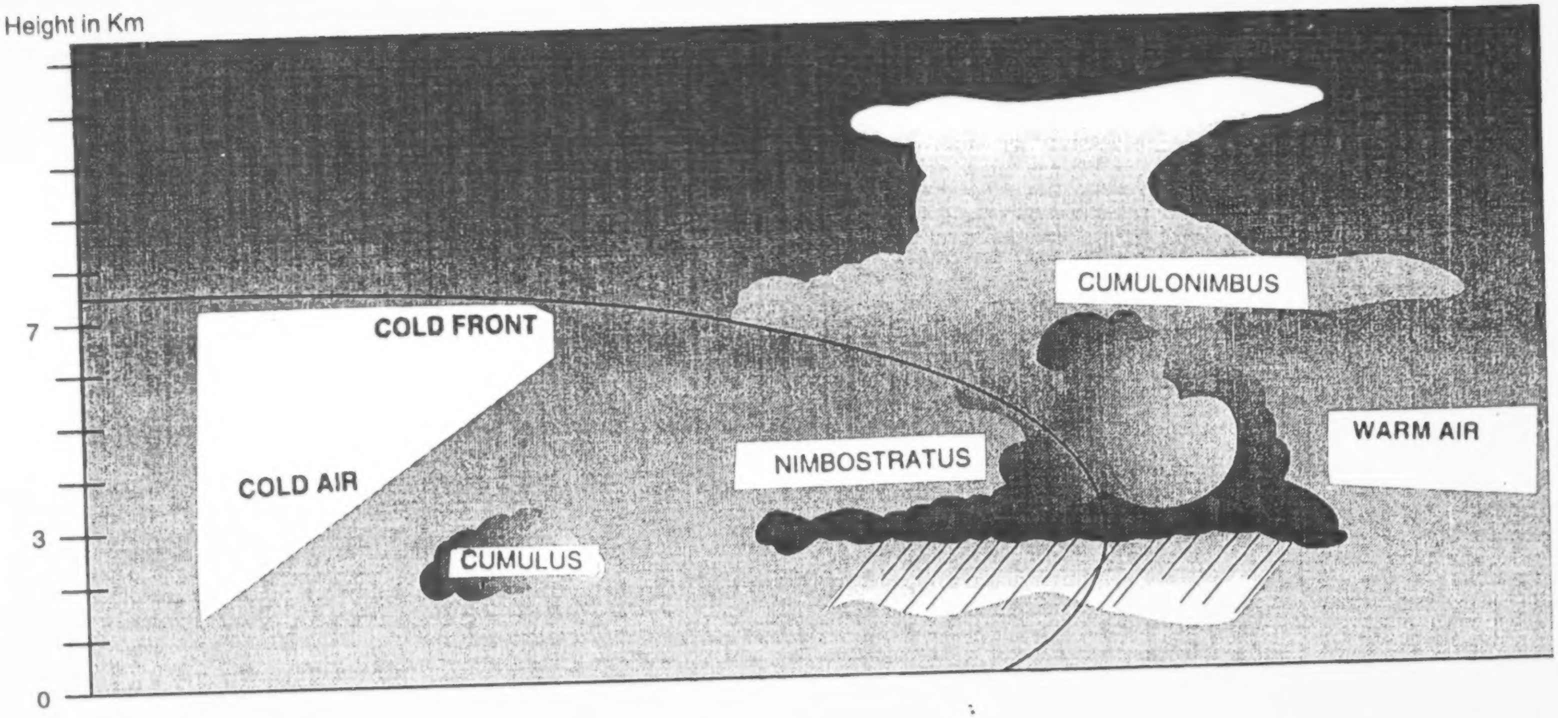
Height in Km
7
3
0
COLD FRONT
COLD AIR
CUMULUS
NIMBOSTRATUS
CUMULONIMBUS
WARM AIR

Figure 4.2.11(1) Idealized diagram of a cold front produced when a mass of cold air overtakes a mass of warm air

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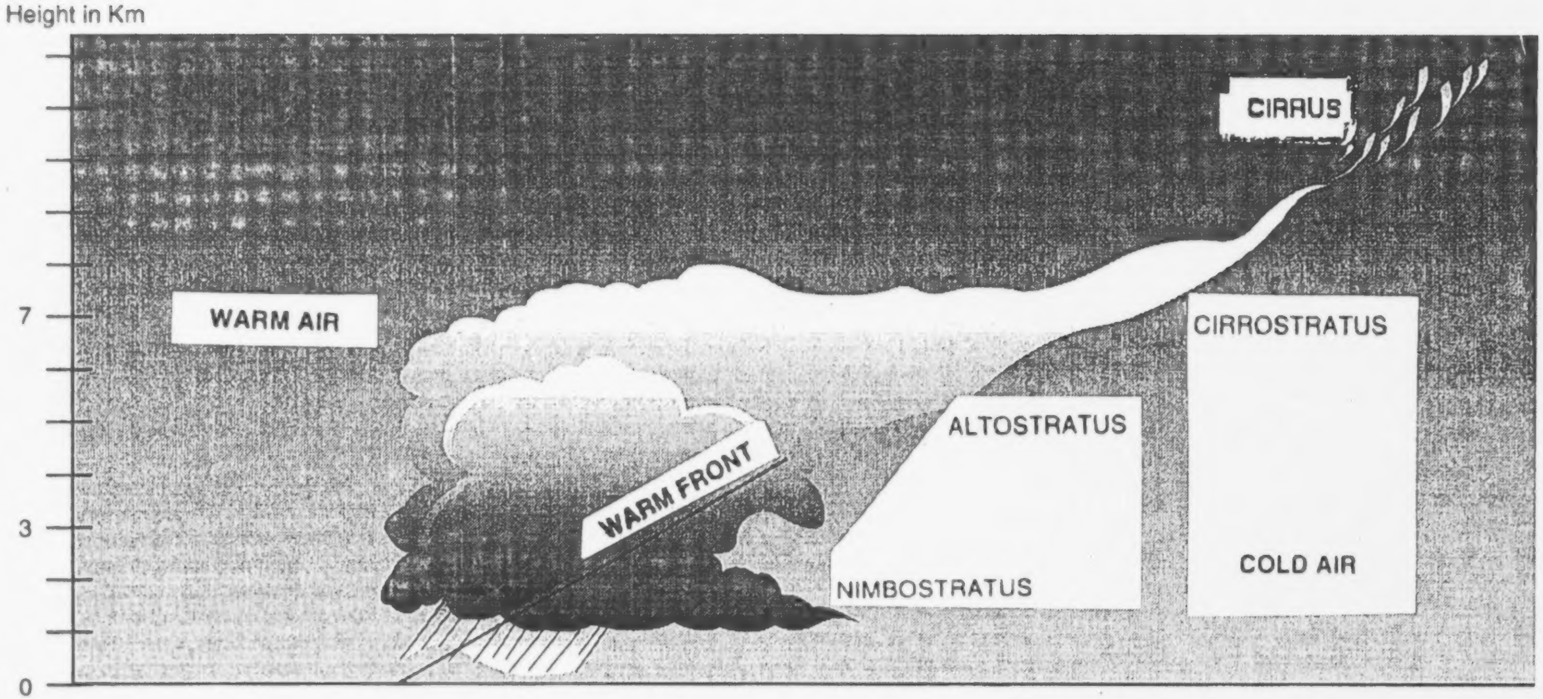
Height in Km
7
3
0
WARM AIR
CIRRUS
CIRROSTRATUS
ALTOSTRATUS
NIMBOSTRATUS
WARM FRONT
COLD AIR

Figure 4.2.11(2) Idealized diagram of a warm front produced when a mass of warm air overtakes a mass of cold air

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STUDENT PAGE 4.2.11 WEATHER FRONTS

Name ____________________

Date ____________________

DATE	TIME	FRONT TYPE (Cold or Warm)	WIND SPEED	WIND DIRECTION	CLOUD DIRECTION	CLOUD TYPE	TEMP °C	PRECIPITATION

ACTIVITY 4.2.12 PREDICTING WEATHER

OBJECTIVES

The students
- Review the success of newspaper weather maps in predicting local weather.
- Analyze weather data to identify the conditions they are related to.
- Predict in the morning what the afternoon weather will be.

BACKGROUND

This activity follows Activities 4.2.10 WEATHER MAPS and 4.2.11 WEATHER FRONTS. In studying newspaper predictions of weather in the region of the school, some inaccuracy in prediction will occur. In PREDICTING WEATHER the students predict in the morning what the weather will be in the afternoon. The activity should be started about a month after the study of newspaper weather predictions has begun. Ideally, the activity will be run for the rest of the year. If the activity is to be carried out for a limited time, try to select two periods about a month long, one in the winter and one in the spring.

STUDENT ROLE

Meteorologist

MATERIALS

Learning Calendar data
Student Pages 4.2.10 WEATHER PREDICTIONS
4.2.12 AFTERNOON WEATHER

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Have the students review Activities 4.2.10 WEATHER MAPS and 4.2.11 WEATHER FRONTS and note the degree of accuracy of newspaper predictions. Present the problem of**

whether we can predict in the morning what the weather will be like in the afternoon.

Ask such questions as

- How accurate have the newspaper predictions been for the region around our school?
- How many times were they right and how many times were they wrong?
- Can you improve on those predictions?

2. **Analyze the data collected on local wind, temperature, and rain and relate them to the weather maps.**

   Ask such questions as

   - What are the conditions that seem to bring warmer weather?
   - What are the conditions that seem to bring colder weather?
   - What are the conditions that seem to bring changes in wind direction?
   - What are the conditions that seem to bring rain?
   - What are the conditions that seem to bring fog?
   - What are the conditions that seem to bring snow?
   - What information would we use to predict in the morning what the weather will be like in the afternoon?

3. **Have the students make predictions about afternoon weather based on all the information at hand. Have them modify their approach to prediction as needed.**

4. **Have the students use Student Page 4.2.12 AFTERNOON WEATHER to record their predictions and successes.**

5. **Summarize the activity.**

   Ask such questions as

   - What helped us the most in making successful predictions about afternoon weather?
   - How successful were we compared to the weather forecasters?
   - What kinds of things were of special importance in making afternoon predictions in different seasons?
   - How would making short-term predictions about weather be important to indigenous peoples?

EXTENSIONS

Have the students predict
- What the weather will be like the next morning.
- What the weather will be like in the afternoon of the next day.

DASH

STUDENT PAGE 4.2.12
AFTERNOON WEATHER

Name ____________________

Date ____________________

DATE	NEWSPAPER PREDICTIONS	CHECK IF CORRECT	MY OWN PREDICTIONS	CHECK IF CORRECT

ACTIVITY 4.2.13 WIND CHILL

OBJECTIVES

The students
- Carry out a series of investigations on the cooling effect of moving air over wet surfaces.
- Practice using a wind chill chart.
- Develop a set of rules for dressing in cold weather.

BACKGROUND

This activity introduces the concept of wind chill. It is designed to be used at the first of the winter season when the students should begin to dress warmly. The activity uses the study of wind chill to emphasize the importance of wearing proper clothing.

The activity begins with an investigation of evaporation from the skin, demonstrating that wind can remove heat from wet surfaces. The students are then given a wind chill chart to use in adding wind chill safety information to the Learning Calendar.

Interpreting the Wind Chill Chart

It will be necessary to help the students describe the wind chill temperature. First go through the inquiry. Then in discussion draw out the idea that wind can chill a wet surface such as our skin more than calm air at the same temperature. This additional cooling is due to evaporation of moisture. **Wind chill temperature** is an estimate of the calm air temperature that would produce the same chilling of the human body as wind.

Refer to Student Page 4.2.13 WIND CHILL CHART. The curves on the chart are curves of constant **air temperature.** They represent the thermometer readings found in the (0) wind speed column. By following them we can find the additional amount of cooling due to the wind. For example, when the air temperature is 5°C and the wind has a speed of 30 km/hr, the moving air will have the same effect on our body as calm air at about -8°C. The wind chill of -8°C is found at the intersect of the 5°C temperature curve and the 30 km/hr column. In other words, the wind at this speed hitting a human body, a wet piece of cloth, or a lake surface carries away the same amount of heat as calm air at about -8°C. The **"apparent" temperature** of the wind is about the same as the -8°C temperature of calm air. One more example, -40°C wind at 30 km/hr chills about as much as -68°C calm air.

When either calm air or wind-chilled air reaches -28°C or -20°F, unprotected flesh, ears in particular, will freeze after about a minute of exposure. Ears will freeze in about half a minute at temperatures below -54°C or -65°F.

STUDENT ROLE

Researcher

MATERIALS

Water
Thermometers
Pieces of cloth
Cobalt chloride paper
Student Pages 4.2.13A WIND CHILL CHART
4.2.13B USING THE WIND CHILL CHART

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Have the students perform a quick investigation.**

   Have them
   - Wet their index fingers on the right and left hands.
   - Blow on their right finger and not on the left.
   - Report what they feel. (Probe for the observation that the wet finger in the wind feels cooler than the wet finger in calm air.)

2. **Ask the students whether the air in their mouth was cooler than the air in the room.**

   Help them
   - Invent a way to test their answer. (This can be done as a demonstration by putting a clean oral thermometer in the mouth or by blowing on a thermometer. The air in the mouth will normally be warmer than the calm air in the room.)

- Conclude that moving air seems to carry heat away from wet fingers even when it is warmer than the air around the fingers.

3. **Repeat the investigation of blowing on one of two wet fingers.**

   Discuss what happened in the investigation.
   - Ask the students whether they noticed anything else different about their two fingers when they blew on one of them. (Look for the idea that the finger in the moving air dries quicker.)
   - Generalize that moving air seems to cause water to evaporate more quickly than calm air.
   - Ask for other examples of moving air's drying things more quickly.
     (Expect such examples as using a hair dryer, clothes dryer, clothesline, and so forth.)

4. **Have the students investigate how, if at all, the speed of the moving air affects the sense of cooling. Have them invent their own approach.**

   Ask such questions as
   - Was there any difference in our feeling of coolness when we increased and decreased the speed of the air? (Work to agreement that the greater the speed of the air, the cooler a wet finger seems to get.)

5. **Have the students investigate whether there is a real lowering of temperature or it just feels cooler.**
   Have them invent a test. (Tests could be to wet two thermometers or put wet pieces of cloth over them and then blow on one and not on the other.)

   Ask such questions as
   - Was there a difference in temperature? (Work to agreement that there was a difference.)
   - Which thermometer had a lower temperature? (The one that was blown on.)
   - How can we generalize? (Work to the generalization that moving air seems to carry heat away from wet things.)

6. **Have the students investigate to determine whether moving air lowers the temperature of dry thermometers. If no one**

thinks of doing it, move a dry thermometer through the air and compare the temperature reading with that of a thermometer in calm air.

Ask such questions as

- Do dry thermometers respond to moving air in the same way that wet thermometers do? (Generalize that wind carries off heat from wet surfaces, but dry thermometers have the same temperature as the air whether it is moving or calm.)
- If our skin feels cooled in a wind, what does that say about our skin? (Work for the idea that our skin must be moist. This can be tested with cobalt chloride paper.)
- What do you think happens to us when we are in the wind on a cold day? (Get at the idea that we will be cooled to a temperature lower than the temperature of the wind.)

7. **Introduce the idea of wind chill.**

Ask such questions as

- Has anyone heard the of the term “wind chill”?
- What does it mean? (Develop the idea that wind cools or chills moist things below the temperature of the wind. We call this lower temperature the “wind chill temperature.”)
- What happens when our body gets chilled? (Note that if our body gets too cold, our capacity to resist disease is lowered. Cold air can lower our body temperature to a point where we can die. Exposed parts of our body such as ears, fingers, and face parts can freeze, giving us a very painful condition called **frostbite**.)

8. **Have the students use Student Pages 4.1.13A WIND CHILL CHART and 4.1.13B USING THE WIND CHILL CHART.**

Have the students note that

- The wind speed ranges in miles per hour runs across the top of the chart. The wind speed in kilometers per hour runs across the bottom.
- The temperature in Celsius and Fahrenheit is shown vertically at the left of the table.
- Each of the curves represents air of constant temperature. The temperature of calm air is shown in the left (0) speed column.
- The wind chill temperature of a wind at a given speed is read at the intersect of the calm air temperature curve and the wind speed column.

- The wind chill of air at 10°C and 30 mph is about 1°C.
- The wind chill of air at -15°C and 20 mph is about -36°C.
- The wind chill of air at -25°F and 25 km/hr about -66°F.

9. **Go over the safety rules for cold weather.**

   Help the students include the following:
   - In cold weather keep clothes dry. (Clothes can lose up to 90% of their insulating properties when wet.)
   - Wear several layers of clothing so that they can be removed to reduce overheating and sweating.
   - If you cannot get warm, get out of the wind and precipitation.
   - Drink hot fluids.
   - Do not drink alcoholic beverages. Alcohol causes the blood vessels in the skin to open with a rapid loss of body heat.
   - Be sure to keep your feet dry. Change from wet socks into dry socks as soon as possible.

10. **Have the students determine and report wind chill temperatures on the Learning Calendar and alert the school when the wind chill is in the danger zone.**

    Have the students
    - Validate their readings with other DASH classes on days they determine that wind chill presents a safety hazard.
    - Post a wind chill warning.

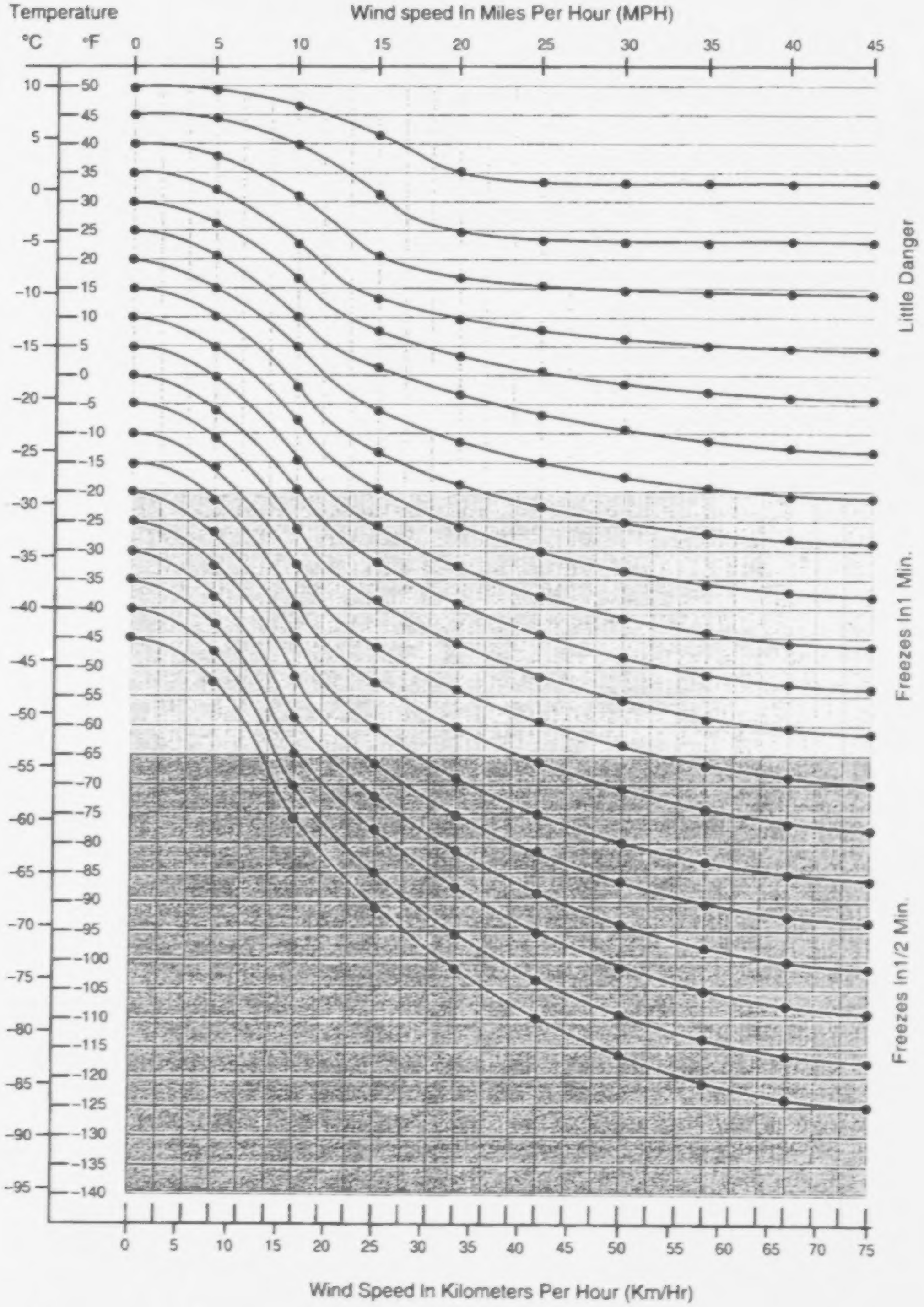
EXTENSIONS

Have the students
- Research and report on the effects and prevention of hypothermia, frostbite, and colds.

SP 4.2.13A
WIND CHILL CHART

Name ______________________
Date ______________________

WIND CHILL CHART
(APPARENT TEMPERATURE)



BEST COPY AVAILABLE

Name________________________

Date________________________

STUDENT PAGE 4.2.13B USING THE WIND CHILL CHART

1. Make up a set of instructions for using the Wind Chill Chart. Include one or two examples of how to use the chart.

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2. Explain how wind lowers the temperature of things that are wet.

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ACTIVITY 4.2.14 FLAT OR ROUND EARTH?

OBJECTIVES

The students
- Identify reasons to support different models of Earth's shape—round, flat, or other.
- Compare observations with different models of Earth.
- Rationalize the model of Earth as a sphere with surface irregularities.

BACKGROUND

In this activity the students look for evidence that indicates the shape of Earth. Evidence points to a planet that is generally round though its surface is irregular and corrugated.

Two of ancient astronomy's more difficult conceptual problems are confronted in this activity:
- What is the shape of Earth?
- Given the logical answer "round," how can Earth, which has innumerable irregularities (mountains, valleys, and some flat areas), be rationally considered as really being round?

Approach

To get at the problems, the students first review observations that point to Earth's being round. They are then asked to make a circle using straight lines and, in the Extension, a circle using *V*-shaped segments. The students are led to see that circles made from such segments appear from a distance to be round or circle-like.

A circle can be made from straight lines in several ways. One way is to divide the sides of a square into three segments. The corners can then be cut off to make an octagon. The process can be repeated to make a 16-sided figure, a 32-sided figure, and so forth. At about the 16-side stage, the emerging figure, from a distance, begins to look like a circle. See Figure 4.2.14.

The students can invent their own approach. Before they start, be sure that they have a working definition of a circle. Get at the idea that a **circle** is a figure with all points on its edge the same distance from the center. On a circle of latitudes drawn on the Earth, the points along the surface of even the tallest mountains or deepest points in the seabed are almost equally distant from the Earth's center. The radius of Earth is about 6400 km; Mt. Everest is about 9 km high. From a few hundred miles in space a radius of 6400 km and a radius of 6409 km appear to be the same length, and Earth looks surprisingly smooth.

STUDENT ROLES

Geographer
Astronomer

MATERIALS

Strong hand lenses
Drawing compass
Two balls (basketball size if possible)
Globe (optional)
Paper
Rulers
Scissors
Pencils
Flashlight or projector
Student Page 4.2.14 FLAT OR ROUND EARTH?

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Introduce the question of whether the world is flat, round, or some other shape.**

   Have the students
   - List reasons that might support each answer—flat, round, or other.
   - Discuss or debate the positions taken.

2. **Provide the students with large balls to use as models of Earth.**

   Have them use one or more of their ball models to explain the following observations:

- When we are standing on the deck of a ship or are sitting in the crow's nest, the sea looks like a great circle of water. Can this be explained by our ball models of Earth? (Any way we look at a ball, we see the edge as a circle. When we are within an inch or so of the ball, the edge becomes an ever smaller circle as we move the eye closer to the ball.)
- When a ship is seen coming over the horizon, its top parts are seen first. Can this be explained by the ball models of Earth? (Have the students try the models.)
- During eclipses of the moon, Earth's shadow crossing over the face of the moon looks like an arc of a circle. (Have the students make such a model using a projector or flashlight.)
- From a spaceship in close orbit, the edge of Earth appears to be curved in all directions. Can this be explained by any of our models of Earth?
- From the moon, Earth looks like a great circle. Can this be explained by any of our models?

3. **Introduce the question "Why does Earth appear to be flat?"**

Ask such questions as

- Where on Earth might it appear to be flat? (Get at the idea that Earth might seem flat to people living in a desert or on great plains. Even on the ocean or at its edge one might see the Earth as being flat. People living in the mountains looking to the horizon could picture Earth as being flat with mountains placed on the flat surface.)
- What would a flat surface such as a piece of paper on edge look like when projected against a screen? (Project a piece of paper's shadow and help the students see that it is a straight line.)
- What would a globe look like when projected against a screen? (Project its shadow and help the students to see that it would be a circle.)
- Can you make a square into a circle by cutting off straight-line segments? (Help the students try to make a circle out of straight lines.)
- Which square made from straight-lines segments looks the most like a circle? (Get at the idea that the one that has the most small lines approximates a circle best.)
- How could we get a circle drawn with straight lines to look even more like a circle? (Get at the idea of drawing more and shorter lines.)

- What do you think a circle drawn with a compass looks like using a hand lens? (Have the students draw such a circle and check their answers with a hand lens.)
- How is this compass circle like Earth? (Get at the idea that though it is irregular, it is very close to being a circle and this is the way that lines drawn around Earth might be.)
- Could you make a globe out of a collection of flat surfaces?
- How can Earth look round from space when we know it to be covered with mountains and valleys? (Get at the idea that Earth is very large compared to the mountains, for Earth looks round and smooth from space. A similar thing happens as we get farther and farther away from our line drawings of a circle.)

EXTENSION

- Have the students make circles using *V*s, *M*'s, dots, and other shapes. Have them develop a working definition of a circle that can accommodate circles made from such segments.

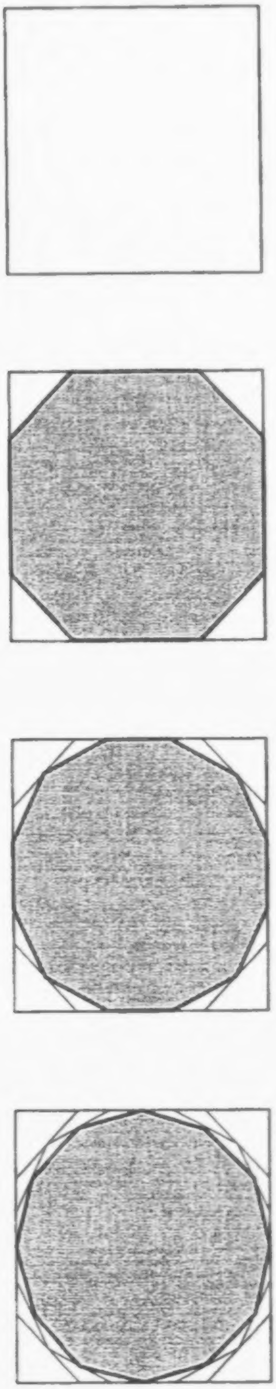

Figure 4.2.14 Progressive increase in the number of sides to approximate a circle

Name________________________

Date________________________

STUDENT PAGE 4.2.14 FLAT OR ROUND EARTH?

1. Use straight lines to draw a figure that looks like a circle.

2. List the evidence that we have that Earth is not shaped like a globe.

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3. List the evidence we have that Earth is shaped like a globe.

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ACTIVITY 4.2.15 LENGTH OF DAY AND NIGHT

OBJECTIVES

The students
- Establish a working definition of night and day.
- Record the times of sunrise and sunset.
- Graph the length of night and length of day.
- Invent and make a Day-Night Clock.

BACKGROUND

This activity gives structure to the study of the night and day. It is basic to and should precede Activities 4.2.16 THE SUN'S SHADOW PATH, 4.2.20 WHEN IS IT IS NOON?, 4.2.21 MAKING A SUNDIAL, 4.2.22 USING A SUNDIAL, 4.2.23 SEASONS AND THE SUN, and 4.2.24 MOON PHASES AND THE SUN.

In LENGTH OF DAY AND NIGHT the students investigate the times of sunrise and sunset and the length of day and night. The activity supports three paths of inquiry: the first is the study of the several kinds of time we use in our daily lives and in astronomy, the second is the continuing correlation of daylight and seasonal events begun in kindergarten, and the third is the study of the moon.

Data Sources

Newspaper data are preferable because they are released on a daily basis. If the students have a view plane that lets them see a distant horizon, they can get their own data for the times of sunrise and sunset. Have them note the time the first bit of the sun appears in the morning and the last bit of the sun disappears in the evening. Missing data for a few days because of clouds will not ruin the inquiry. Sunrise and sunset data are also published in current almanacs. Whatever the source of data chosen, it should be used consistently throughout the year.

Frequency of Recording

After the students understand how to mark the day and night bands on the student pages, have them record the sunrises and sunsets once a week at the time they record the sun's shadow using the gnomon. See Activity 4.2.16 THE SUN'S SHADOW PATH.

Almanac Data

Almanac data are given for local time at selected latitudes, most often 10 degrees apart. Usually schools will not rest on the 20°, 30°, 40°, or 50° lines of latitude but rather between them. Select either the nearest latitude or estimate some time between.

Newspaper Data

Newspapers may take data directly from an almanac or they may correct them to clock time. It will be worthwhile to have the students contact newspapers to find out how they get their sunrise and sunset data.

Daylight Saving Time

Daylight saving time starts on the first Sunday in April at 2:00 a.m. when clocks are advanced one hour. It ends on the last Sunday in October at 2:00 a.m. when the clocks are set back one hour. Daylight saving time is used in most U.S. states except Arizona, Hawai‘i, and part of Indiana. The U.S. territorial areas of the Pacific, the Virgin Islands, and Puerto Rico stay on standard time throughout the year. A mnemonic will help the students remember how to set their clocks:

Spring forward, fall back.

Day-Night Clock

An example of a Day-Night Clock and its assembly are shown in Figure 4.2.15(1). To get a sense of the way the relative amounts of day and night change through the months of the year, set one clock at the beginning of each month and keep it at that setting throughout the year. A collection of these Day-Night Clocks will help in correlating daylight with other seasonal information when working on Activity 4.2.23 SEASONS AND THE SUN.

Relating Day-Night Graphs and Clocks

The Length of Day and Night Graphs can be made show the information in a continuous form similar to that of the Day-Night Clock. Simply roll the Length of Day Graph into a tube and align the “midnights.” Follow the same procedure with the Length of Night Graph but align the “noons.” For example, noon November 2 would be aligned with noon November 2 or midnight November 2 aligned with midnight November 2. With this alignment the flow of time looks like a screw thread.

COMMENT ON ASTRONOMY

There are several different but reconcilable explanations of the movement of the stars, planets, moon, and sun as seen from Earth. DASH deals with these explanations as the students are developmentally prepared to understand them.

Commonsense View

The commonsense explanation is a simple description of a sky filled with heavenly bodies, all traveling day and night from east to west. Up to the 16th century observations of the sky led astronomers to assume this was what was occurring. It followed that Earth would be at the center of this universe.

The Copernican View

After Copernicus published his model of a sun-centered solar system in 1543, astronomers slowly came to the conclusion that the observed movement of heavenly bodies is due to the rotation of Earth on an axis. It is the sun that is at the center of our solar system. In this the 20th century our theories have gone further and placed our solar system on the outer rim of a galaxy, and this galaxy has become but one of billions of galaxies all fleeing an unknown center of origin in the "Big Bang."

The DASH Reconciliation

In DASH, the students deal first with the observed sky. No attempt is made to explain the movement of heavenly bodies until grade 5. By then the students will have a thorough commonsense experience in describing the heavens. In grade 5 they are introduced to the Earth-centered model of the heavens attributed to Ptolemy in 200 AD and then to the model of Copernicus. The two models are reconciled so their commonsense observations can be understood within the sun-centered model.

By grade 5, the students find that the Earth-centered model accounts for only part of their growing body of observations. The sun-centered model is needed to explain the many phenomena they learn about as users of telescopes and processors of information from space travels.

An Approach to Transition

To help the students make the transition from the commonsense model of the heavens to the more abstract model of Copernicus, it may be useful to describe what they see as the **"apparent" motion** of the stars, sun, planets, and moon. This will give a hint of the changes to come in the way we describe the movement in the sky.

STUDENT ROLE

Astronomer

MATERIALS

Paper plates
Scissors
Brad paper fasteners
Markers or crayons
Watch (if data are to be taken from observation)
Almanac or newspaper
Student Pages 4.2.15A LENGTH OF DAY GRAPH
4.2.15B LENGTH OF NIGHT GRAPH

PRODUCTS

Day–Night Clocks
Completed Student Pages

PROCEDURES

1. **Review the students' concept of day and night.**

   Ask such questions as
   - What do we mean when we talk about a day?
   - When does the night end and the day begin? (Get a working definition of time of sunrise.)
   - When does the day end and the night begin? (Get a working definition of time of sunset.)
   - What is confusing about defining the time passage from day to night and night to day? (Work to the idea that dawn and twilight are the periods of light that come before sunrise and after sunset.)

2. **Point out that we need to keep a record of sunrise and sunset to collect data on the movement of the sun during the different seasons. Set up a Responsibility Chart for recording such data on the Learning Calendar.**

3. **Have the students make an entry on Student Page 4.2.15A LENGTH OF DAY GRAPH at the same time they record the sun's shadow using the gnomon in Activity 4.2.16 THE SUN'S SHADOW PATH.**

   Have them
   - Note that 12:00 noon is in the center of the Length of Day Graph.
   - Note that midnight is at the two ends of the graph.
   - Color in the night interval from midnight to sunrise and from sunset to midnight each time an entry is made. See Figure 4.2.15(2).

4. **Have the students make an entry on Student Page 4.2.15B LENGTH OF NIGHT GRAPH at the same time they make an entry on Student Page 4.2.15A LENGTH OF DAY GRAPH.**

   Have them
   - Note that 12:00 noon is at the two ends of the Length of Night Graph.
   - Note that midnight is at the center of the graph.
   - Color in the night interval from sunrise to sunset.

5. **Right before December 25 have the students analyze the data.**

   Ask such questions as
   - What happens to the length of day as we approach December 25? (Work for agreement that it gets shorter.)
   - What happens to the length of night? (Work for agreement that it gets longer.)
   - What happened to the two graphs when we went to standard time from daylight saving time? (Observe that there was a jump of an hour.)
   - When should night and day be about equal in length? (Get predictions and mark them on the Learning Calendar. Work toward a spring date a little after mid-March.)
   - During daylight saving time where do the midpoints between sunrise and sunset fall? (Noon and midnight will be an hour earlier than the midpoint of standard time.)

6. **Have the students invent and make a class Day–Night Clock showing the times of sunrise and sunset and the relative amounts of night and day. See Figure 4.2.15(1). Put paper plates, brads, and pens in the Inventor's Box.**

7. **Have the students relate the Day–Night Clock to the Length of Day and Night Graphs.**

   Ask such questions as
   - How does Day-Night Clock show the information recorded on the Length of Day and Night Graphs?
   - How could the graphs be made to look like a clock face? (They could be rolled into a tube.)
   - When rolled into tubes, how do the Length and Length of Night Graphs compare? (Work to the observation that they are almost the same.)
   - What reason is there for not using sunrise as the starting time on a clock? (Get at the variability of sunrise and the changing length of a day based on sunrise.)

8. **Summarize the activity in the spring by having the students make a bulletin board display.**

   Have the students
   - Post the Day-Night Clock representing the daylight and night hours at the first of each month.
   - At the end of the year post the Length of Day and Length of Night Graphs showing the data points on the graphs that are related to the clocks.
   - Use these data in Activities 4.2.23 SEASONS AND THE SUN and 4.2.24 MOON PHASES AND THE SUN.

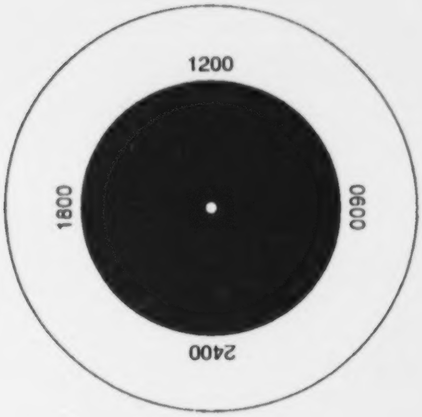
EXTENSION

- Have the students use almanac data to make Day-Night Clocks showing the times of daylight at other latitudes.

PAPER PLATE 1

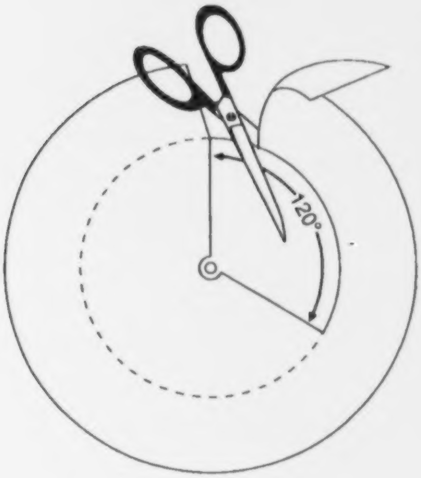
Paint center black.

Number 24 hours around the inside of rim.


1200
1800
0600
2400

PLATES 2 AND 3

Cut out 120° wedges.
Paint each one yellow.
Poke a hole in each.



ASSEMBLE DAY-NIGHT CLOCK

Place both 120° yellow wedges on black center.

Attach to clock face with a brad in the center hole.

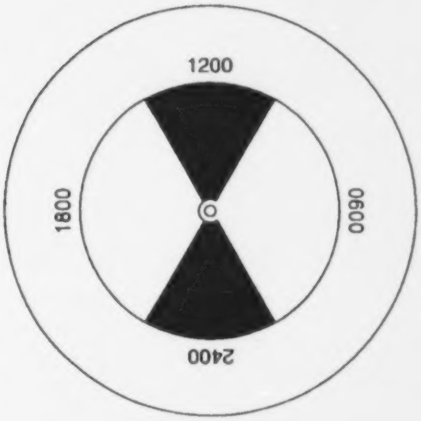
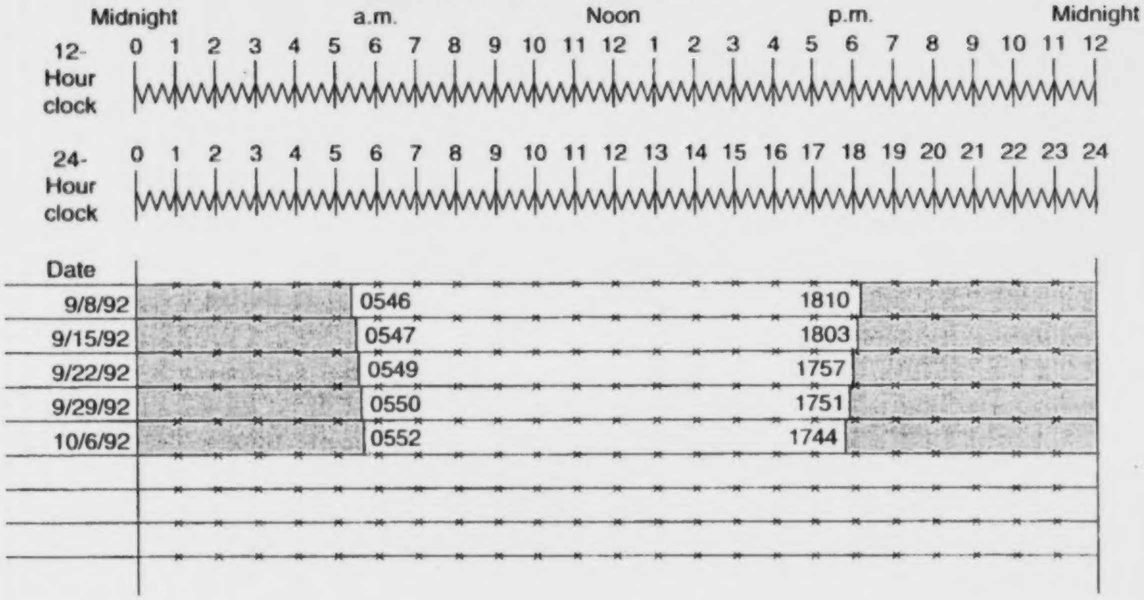

1200
1800
0600
2400

Figure 4.2.15(1) Day-Night Clock

LENGTH OF DAY GRAPH



LENGTH OF NIGHT GRAPH

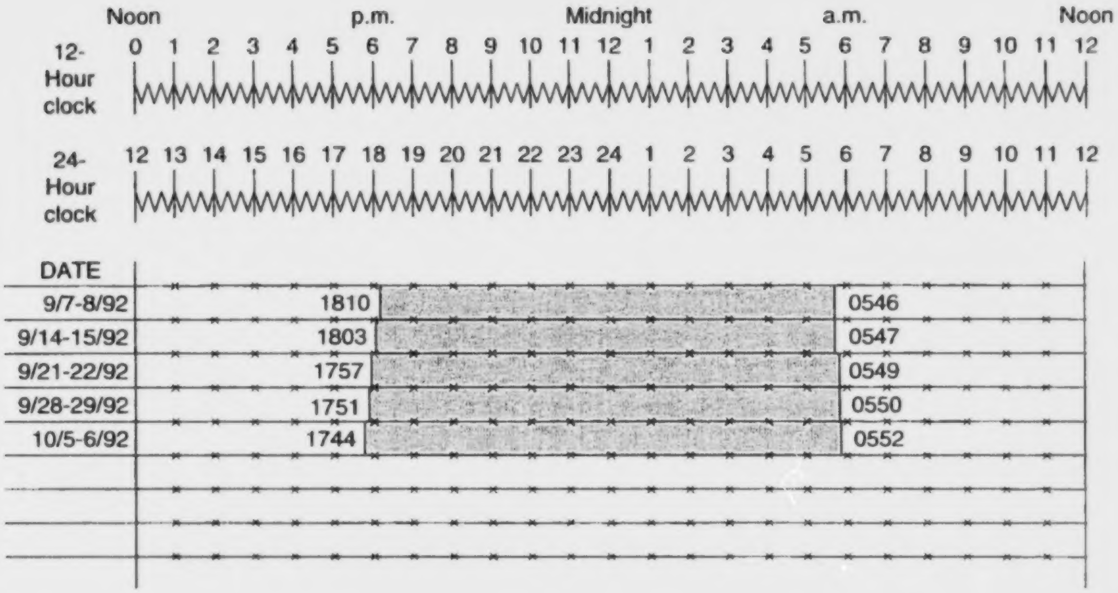
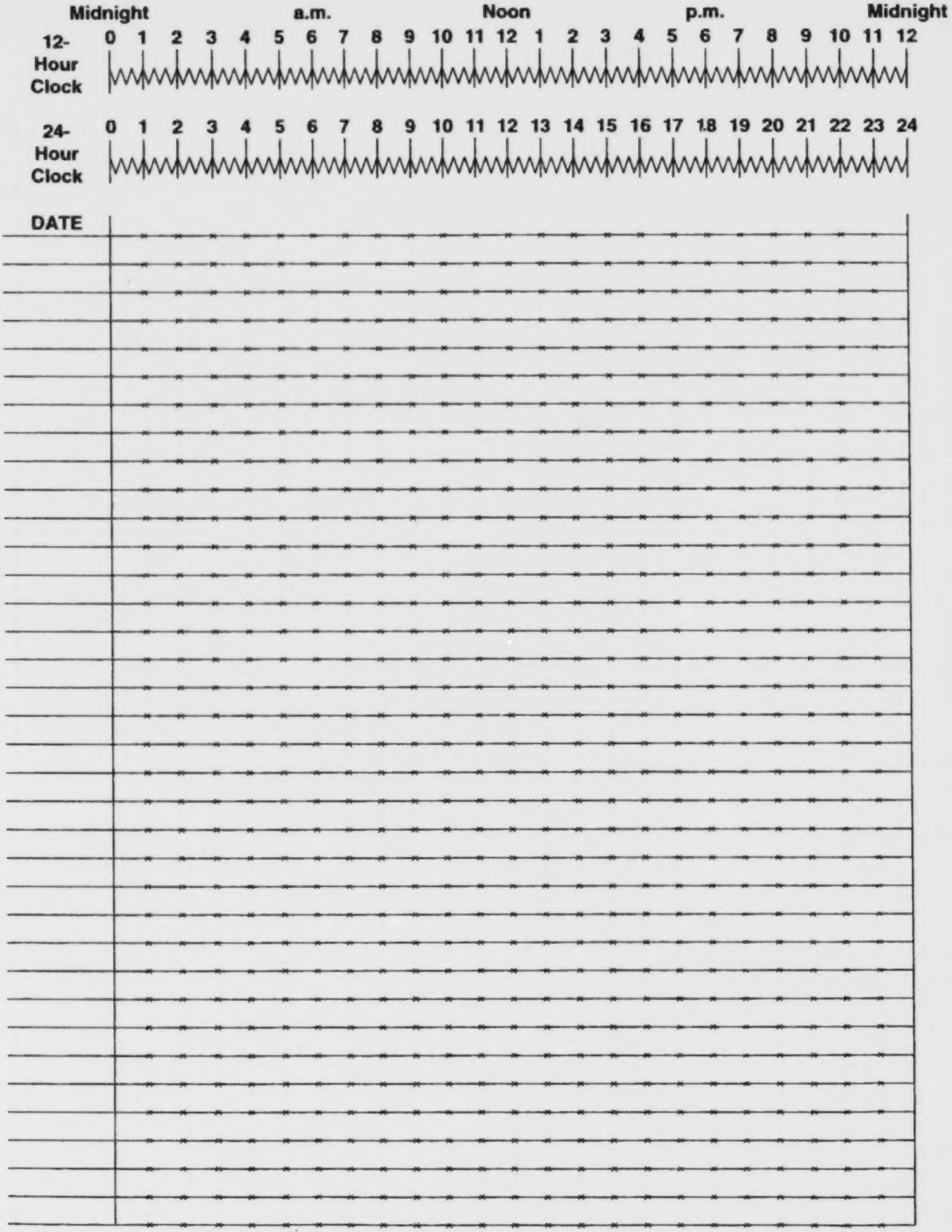


Figure 4.2.15(2) Examples of Length of Day and Length of Night Graphs at 20° N latitude

SP 4.2.15A
LENGTH OF DAY GRAPH

Name ____________________

Date ____________________



DASH

SP 4.2.15B
LENGTH OF NIGHT GRAPH

Name ____________________

Date ____________________

	Noon						p.m.						Midnight						a.m.						Noon
12-Hour Clock	0	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
24-Hour Clock	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7	8	9	10	11	12

DATE

ACTIVITY 4.2.16 THE SUN'S SHADOW PATH

OBJECTIVES

The students
- Make a gnomon to record the sun's shadow.
- Analyze the seasonal shadow changes of the sun's path across the sky.
- Develop a model of the sun's seasonal illumination of Earth.

BACKGROUND

The Gnomon

This activity is the first of a series of four activities dealing with the apparent daily and seasonal movement of the sun and its shadow. It precedes Activities 4.2.20 WHEN IS IT NOON?, 4.2.21 MAKING A SUNDIAL, AND 4.2.22 USING A SUNDIAL.

THE SUN'S SHADOW PATH uses an ancient device called a **gnomon** or shadow post. Gnomon is pronounced "no-mon" with the **g** silent. The gnomon used here is a 6- or 8-penny nail driven into a board that can be taken into the field. The board holds a pad of legal-size paper. **For safety purposes** the head rather than the point of the nail should stick out of the board. See Figures 4.2.16(1) and (2) for help in making and using a gnomon. A hammer can be used to make the nail vertical. Verticalness can be checked with any right-angle corner from a sheet of notebook paper. Cut a 5–6 cm slot from the edge of a legal-size pad at the middle of the long side so that the pad will fit around the nail gnomon.

In the Northern Hemisphere the students will find that the shadows will get longer as the season progresses toward December 25 and shorten thereafter. On any given day they will find that the shadow is shortest at about noon. This observation leads to the next activity on finding the solar noon for their geographical location. See Activity 4.2.20 WHEN IS IT NOON?

Frequency of Measurement

After all the students have had a chance to use the gnomon, have groups make a set of shadow measurements once a week. Record a single set on one sheet of a legal pad of paper. A set should consist of one morning, one noon, and one afternoon shadow record. Select three convenient times and always make the shadow recording at the same time.

If an observation cannot be made within 10 minutes of the set time, postpone the observation because east-west movement of the sun is quite fast. North-south movement of the sun's shadow is fairly slow, so if only one recording is possible on, say, a Monday, the other two readings can be made later in the week. A gap in data will not affect the investigation. The clock time of the observation is much more crucial than the date of observation.

View Site

The view site should be as open as possible to sunlight. The site should receive early morning and late afternoon and noon sunlight and be as level as possible. When any of these conditions of light cannot be met, different sites can be used for the morning, noon, and afternoon readings as long as the pad is given the same north-south orientation. If the sites are to be changed, align the gnomon recording paper with a magnetic compass so one edge runs along the north-south magnetic line. See Figure 4.2.16(2).

Shadow *V's*

In addition to getting longer, the angle between any two shadow lines will get progressively smaller up to sometime around December 25. After that it will grow larger. These two observations are verified by drawing connecting lines from the tips of the morning and afternoon shadows to the tip of the noon shadow. This will form a *V* that can be traced and cut out. The *V*s, once cut out, can be compared. These *V*s should be kept. See Figure 4.2.16(2).

STUDENT ROLES

Astronomer
Chronologist
Climatologist

MATERIALS

12" x 12" x 1" wood board (3/4" plywood will work well)
Hammer
6- or 8-penny nail
Right angle to check verticalness of nail gnomon
Legal-size pad
Saw or knife to cut paper
Magnetic compass
Student Pages 4.2.16 THE SUN'S SHADOW PATH

PRODUCTS

Gnomons
Seasonal shadow data
Completed Student Pages.

PROCEDURES

1. **Explore the students' understanding of the path of the sun across the daylight sky. Record all unanswered questions in the Wonder and Discover Book.**

   Ask such questions as
   - Where does the sun rise in the morning and set in the evening? (Get agreement that it rises toward the east and sets toward the west.)
   - Where is the sun at noon? (Work for the idea that the sun is in the middle of its path across the sky. Some students may have noted that it is not quite in the middle when the clock shows noon. Make any such comment a Wonder and Discover item.)
   - How might we follow the position of the sun as it goes across the sky? (Work for such ideas as using our fists to measure the angle the sun makes with the sunrise horizon at different times of day, following its image in a mirror, and following its shadow. If the latter ideas are not suggested, probe further.)
   - Does the sun give us any evidence of its movement that we can see? (Get at the idea that we can see it in reflections and can see where it leaves a shadow.)
   - If we know the time of rising and the time of setting, when would we expect the sun to be halfway across the sky, or highest in the sky? (Help the students work to the idea that the sun would be at the time halfway between the rising and setting times, or noon.)
   - What time would this be today? (Get the times of sunrise and sunset from the Learning Calendar and find the time halfway between.)
   - Where would you expect the sun's shadow to point? (Get predictions.)

2. **Explain that to collect data to answer questions about the sun's shadow, we need a "gnomon" or vertical shadow post. This shadow post should allow us to record the sun's path on a sheet of paper. Put boards, nails, and hammers in the Inventor's Box.**

   Give groups of students the responsibility for
   - Making gnomons. (See Figure 4.2.16(1).
   - Demonstrating to the class how they checked and adjusted the gnomon so that it is vertical.

3. **Have the students invent a recording system.**

   Ask such questions as
   - How could we make a record of where the sun's shadow falls at different times during the day? (Work for the idea of recording an outline of the shadow on a sheet of paper.)
   - How could you be sure the paper is always in the same position? (Work for such things as using a compass to orient the paper, marking a line on the ground along which the paper can be placed, and placing the edge of the paper along a sighting line defined by two other objects.)
   - Where will the shadow be in the morning? (Work for at least one hypothesis that it will fall on the left side of the paper as one faces north.)
   - Where will the shadow be in the afternoon? (Work for at least one hypothesis that it will fall on the right side of the paper as one faces north.)
   - Where should the gnomon be so that you can record shadows in all directions? (Work for agreement that it will need to be near the middle of the paper.)

4. **Have the students orient their gnomons and take readings once every hour throughout the day and at the hour they predicted the sun would be in the middle of its transit or passage across the sky. At each sighting have the students demonstrate to you that their realignment of the pad is the same as their first time out. Discuss the activity at the time of observation.**

Ask such questions as.

- Did any group have difficulty aligning their recording paper when they went outdoors? (Have the students report on what they did to check alignment.)
- Where was the sun's shadow before noon? (In the Northern Hemisphere schools above latitude 23° N, the shadow will usually be in the upper left side of the paper when the students face north.)
- Where was the shadow after noon? (Work for agreement that it was on the opposite side of the page from the morning shadow and in the same upper or lower half of the paper.)
- How close was our prediction about when the sun was in the middle of the sky? (Work for agreement that it was at least close. However, clock noon and solar noon will at most places be slightly different. This will be dealt with in Activity 4.2.20 WHEN IS IT NOON? and for now any questions that arise can be put in the Wonder and Discover Book.)
- How does the noon shadow compare with other shadows? (It will be the shortest shadow.)

5. **Tell the students that for 10 or so days we will make a record of the length of the shadow three times a day—first thing in the morning, at noon, and last thing in the afternoon. We will do this at the same time every day.**

Make the number of observations large enough so that all the student groups have a chance to use the gnomon.

Have the groups

- Use the same gnomon for measurement and set the times for observation.
- Use the same pad of paper, reserving a different sheet for each set of three readings.
- Record the outline of the shadow of the post. (If the shadow goes off the paper, have them draw the shadow to the edge of the paper, measure the total length, and record this length.)
- Record the time and the date when the drawing was made on the shadow line.
- After the initial measurement period make measurements once a week. (The shadow length will change but slightly during a week, so in times of bad weather a morning reading on a Monday or any other day in the week can be added to a noon and afternoon

reading on Wednesday or any other combination of days in the same week. If the weather is extremely bad, several weeks of missing data will not destroy the investigation.)

6. **Have the students make a series of hypotheses.**

Ask such questions as
- Will the shadows be thicker, thinner, or the same thickness as the gnomon?
- What will be the longest shadow of the day? Why?
- What will be the shortest shadow of the day? Why?
- What will happen to the lengths of shadows over a week's time? (Encourage the students to ask their own questions about the length of the shadows.)
- When will we get the longest noon shadow during the year?
- Will the "getting longer" process stop? If so, when?
- When in the year will we get the shortest shadows?
- Can we use the gnomon to tell us where the sun is rising on the horizon?
- Can we use the gnomon to tell us where the sun is setting on the horizon?

7. **After December 25 have the students analyze the data collected to that point.**

Have groups of students
- Trace the shadow data from the gnomon record sheets.
- Cut out and date the shadow *V*s. See Figure 4.2.16(2).
- Pile the *V*s in date order, one on top of the other with the most recent *V* on the bottom. After interpreting the data, reverse the order of piling.
- Explain what the stack of *V*s tells us. (For Northern Hemisphere classes, help the students see that the sun has been moving south as the shadow grew longer. The reverse process occurs in the Southern Hemisphere.)
- Place a *V* on a globe with the apex of the *V* on the location of the school and the noon shadow pointing north.
- Explain how the *V* helps us locate where the sun was when the morning and afternoon measurements were taken. (Help them see that it shows the direction the sunlight was coming. See Figure 4.2.16(3).)
- Use the beam of a flashlight and a globe to show how the shadows could have changed since the measuring first began.

- Check their hypotheses from Procedure 6.
- Predict what the stack of *V*'s will look like when analyzed at the end of the school year.

8. Near the end of the school year again have the students analyze the shadow data as in Procedure 7 to prepare for Activity 4.2.23 SEASONS AND THE SUN.

Ask such additional questions as

- Where was the sun when it cast the first noon shadow we measured using our gnomon? (Have the students use a *V* and a globe to show the location.)
- Where was the sun when it cast its noon shadow right before December 25? Its noon shadow at the spring equinox? Its noon shadow today?
- How would you describe the movement of the sun during our school year? (In the Northern Hemisphere the sun seems to move first south then north.)
- Can you use a beam of light to show how the sunlight changes in the Northern and Southern hemispheres through the seasons? (Let the students explore with spheres in the beam of a projector.)
- What happens to the sunlight at the North Pole as the sun moves south? (Work toward the observation that the pole goes into shadow or night.)
- What would you expect the temperature to be near the North Pole where it is night for much of the year? (Work for the idea that it would be cold. This can be verified by comparing the temperatures of cities in the north such as Nome, Alaska, with a city such as Dallas, Texas, in the south. See an almanac for data.)
- What time of day is it hottest? (Get agreement that it is hottest a little after the time when the sun is in the middle of its passage across the sky. It takes time to heat the Earth after the cold of night.)
- When would we expect that seasonal weather would to be the hottest? (Work for the logic that it would be hottest when the sun is closest to being above us in its north-south movement.)
- When is it really the hottest? (Get agreement that it is hottest after summer begins. It takes some time for the environment to warm up after the cold times of winter, so the hottest times will be after the summer solstice.)

9. **Have the students use Student Page 4.2.16 THE SUN'S SHADOW PATH and explain how the sun determines the seasons on Earth.**

EXTENSIONS

- Have the students compare the temperatures of different cities around the world and their distance from the equator in degrees.

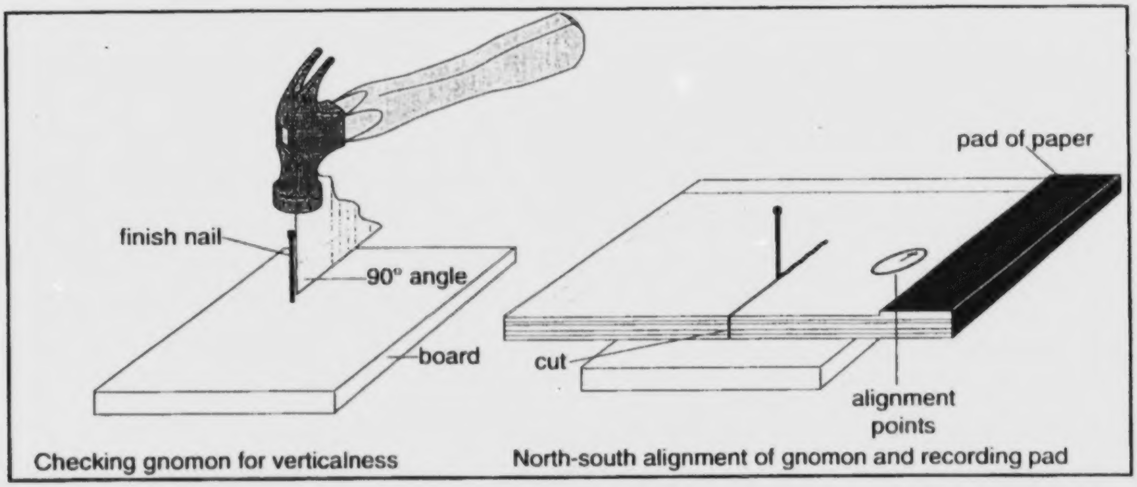

pad of paper
finish nail
90° angle
board
cut
alignment points
Checking gnomon for verticalness
North-south alignment of gnomon and recording pad

Figure 4.2.16(1) Making a gnomon

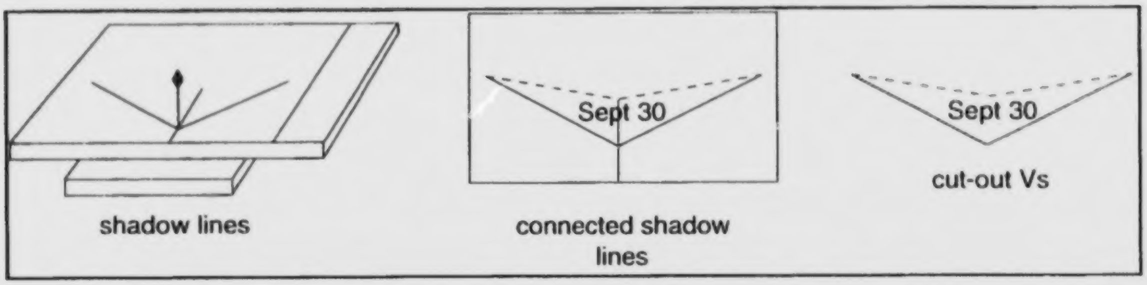

Sept 30
Sept 30
shadow lines
connected shadow lines
cut-out Vs

Figure 4.2.16(2) How to make cut-out V's from gnomon shadow data

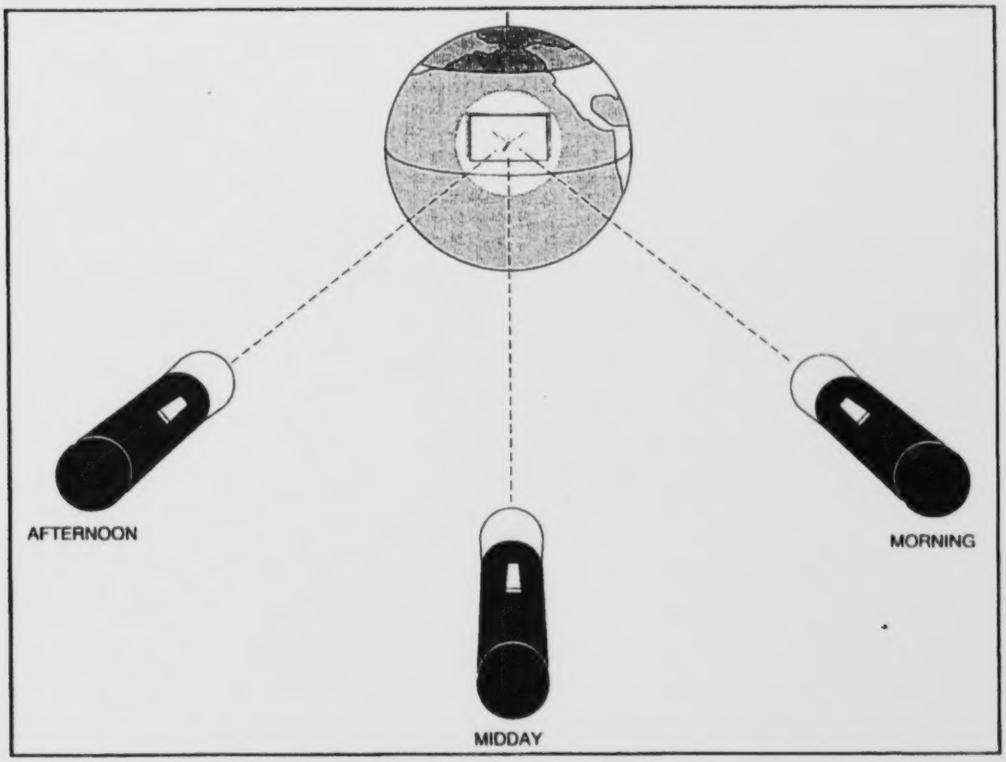

AFTERNOON
MORNING
MIDDAY

Figure 4.2.16(3) Flashlight-globe model of sun below the equator showing gnomon shadows and the polar shadow regions

DASH

Name________________________

Date________________________

STUDENT PAGE 4.2.16 THE SUN'S SHADOW PATH

Explain the relationship between the path of the sun and the seasons.

ACTIVITY 4.2.17 PLANETARIUM

OBJECTIVES

The students
- Assemble models of the sky.
- Identify the constellations in the models.

BACKGROUND

This activity is designed to provide the students with miniature planetariums to study major constellations and the paths of the sun, moon, and planets through the heavens. It should be followed by Activities 4.2.18 USING THE PLANETARIUM and 4.2.19 PLANETS. Some students may have studied the constellations around the pole star in DASH 3. Now the constellations of the zodiac are added.

Mnemonic

Some students may want to invent their own mnemonic or use the one below to recall the order of the zodiacal constellations.

Capricornus, **A**quarius, **Pis**ces, **A**ries, **T**aurus, **G**emini,
Cancer, **Le**o, **Vi**rgo, **Li**bra, **S**corpius, **S**agittarius

Your **CAP is AT G.C. LeViLiSS's.**

Zodiacal Clock

The zodiacal constellations provide us with a year-long clock. The constellations rising at sunset change each month. Students who have taken grade 3 DASH may have already found that the Big and Little Dippers have different locations in the sky each month when viewed at the same hour of the night.

Each month one of the zodiacal constellations will not be visible because it will be behind the sun. We say the sun is "in" the constellation that it obscures. The other constellations will be visible in the evening and/or early morning sky.

Constellation Names

The constellations of the zodiac as we commonly know them were named by the Greeks and Babylonians. Since that time the constellations have shifted so that each of the 12 members of the zodiacal band appears almost one month later than it did in ancient times. The present periods of obscuring are shown in the table below. These periods are contrasted with the ancient astrological periods that some students may know.

Table 4.2.17 Zodiacal constellations and the sun

Constellation Names in Zodiacal Order	Present-Day Dates When Sun Is in the Constellation	Ancient Astrological Periods
Capricornus, the Goat	Jan. 19 — Feb. 15	Dec. 22 — Jan. 17
Aquarius, the Water Bearer	Feb. 16 — Mar. 11	Jan. 18 — Feb. 14
Pisces, the Fishes	Mar. 12 — Apr. 18	Feb. 15 — Mar. 20
Aries, the Ram	Apr. 19 — May 13	Mar. 21 — Apr. 19
Taurus, the Bull	May 14 — June 20	Apr. 20 — May 20
Gemini, the Twins	June 21 — July 19	May 21 — June 21
Cancer, the Crab	July 20 — Aug. 9	June 22 — July 22
Leo, the Lion	Aug. 10 — Sept. 15	July 23 — Aug. 22
Virgo, the Virgin	Sept. 16 — Oct. 30	Aug. 23 — Sept. 22
Libra, the Balance	Oct. 31 — Nov. 22	Sept. 23 — Oct. 23
Scorpius, the Scorpion	Nov. 23 — Dec. 17	Oct. 24 — Nov. 2
Sagittarius, the Archer	Dec. 18 — Jan. 18	Nov. 23 — Dec. 21

*Adjust for Leap Years

In this activity the students make two sizes of planetariums—large for in-class work and small for personal home use. Both show two views. The inside view looks from Earth to the stars, and the outside view looks at our star system from far out in space. The large planetariums can be treated as jigsaw puzzles. Instructions for assembly are found in the student pages.

STUDENT ROLE

Astronomer

MATERIALS

Scissors	
Glue	
Cardboard	
Student Pages	4.2.17A PERSONAL PLANETARIUM 4.2.17B LARGE PLANETARIUM

PRODUCTS

Planetarium models
Completed Student Pages

PROCEDURES

1. **Explain to the students that we need to complete our model of the major constellations of the northern sky. Have them use Student Pages 4.2.17A–B to construct two kinds of planetariums—small personal models for use at home and large models for use in class.**

   Have the students
   - Each build a small personal model.
   - Work in groups to build large class models using the small models as guides.

2. **Have the students check their large planetarium with those of other groups to make sure it is assembled properly.**

   Have them
   - Develop a mnemonic to remember the sequence of the constellations of the zodiac.
   - Locate where they would have to be in order to see the inside view of their planetarium. (Work toward agreement that this is the view from Earth.)
   - Locate where they would have to be to see the outside view. (Work to agreement that they would have to be in space beyond the galaxies above Earth.)

EXTENSION

Have the students
- Research the constellations of the Southern Hemisphere.

Name________________________

Date________________________

STUDENT PAGE 4.2.17A PERSONAL PLANETARIUM

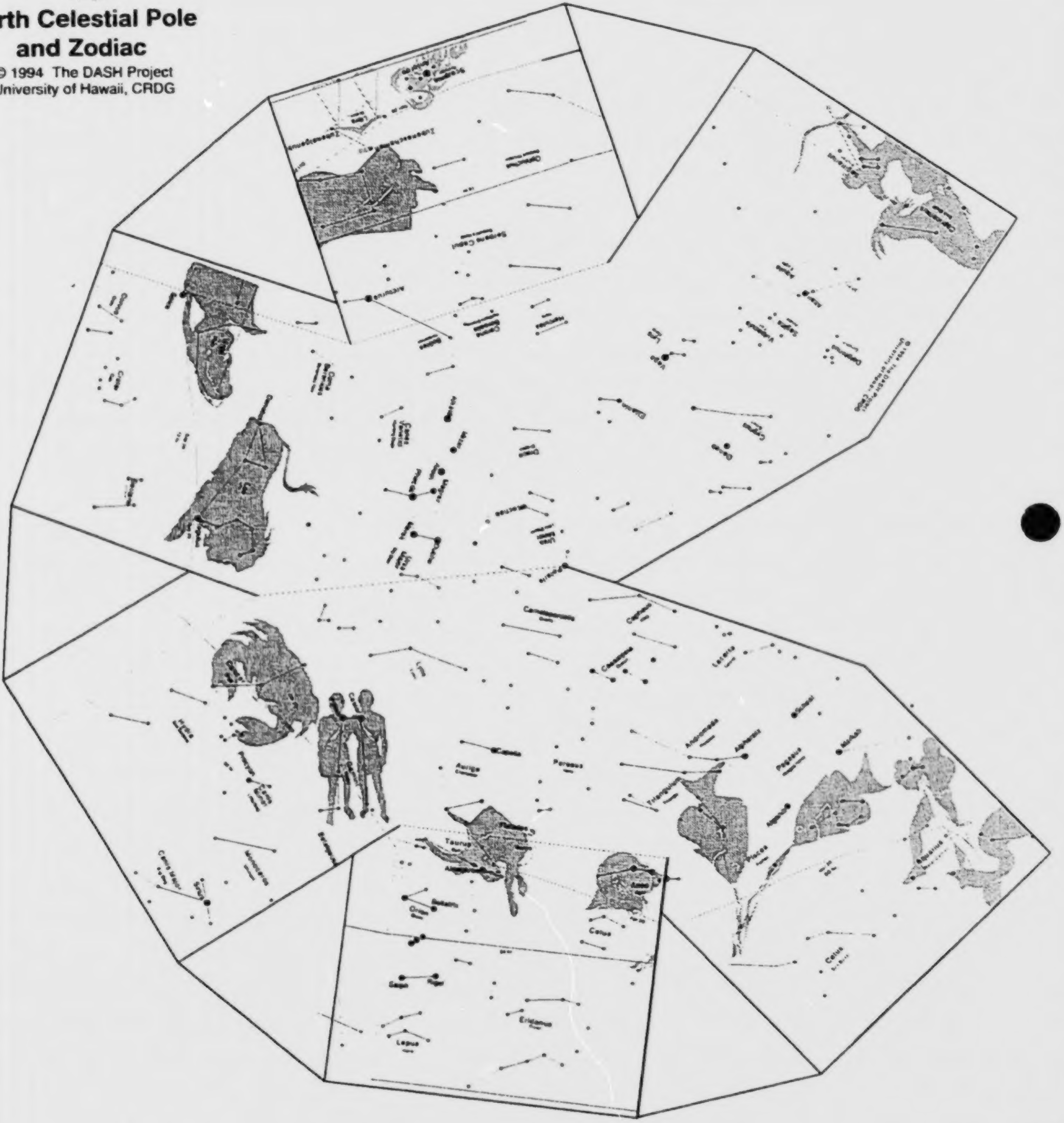
Use the following instructions and the Planetarium Sheets to make a small personal planetarium.

- Glue the inside and outside together so that the same stars are directly on top of each other.
- Check the alignment by pressing a pin through 3 or 4 stars. If they are properly aligned, the pin will go through the same star on either side of the model.
- Cut out the planetarium along the heavy lines.
- Fold the planetarium into a six-sided tent using the dotted fold lines.
- Glue or tape the tabs between the two layers of the planetarium. If tape is used, the planetarium can be disassembled, folded flat, and stored.

DASH—*IN*

1 page

North Celestial Pole and Zodiac


Auriga
Perseus
Taurus
Orion
Cetus
Eridanus
Lepus
Pegasus
Pisces

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DASH—*OUT*

1 page

North Celestial Pole and Zodiac

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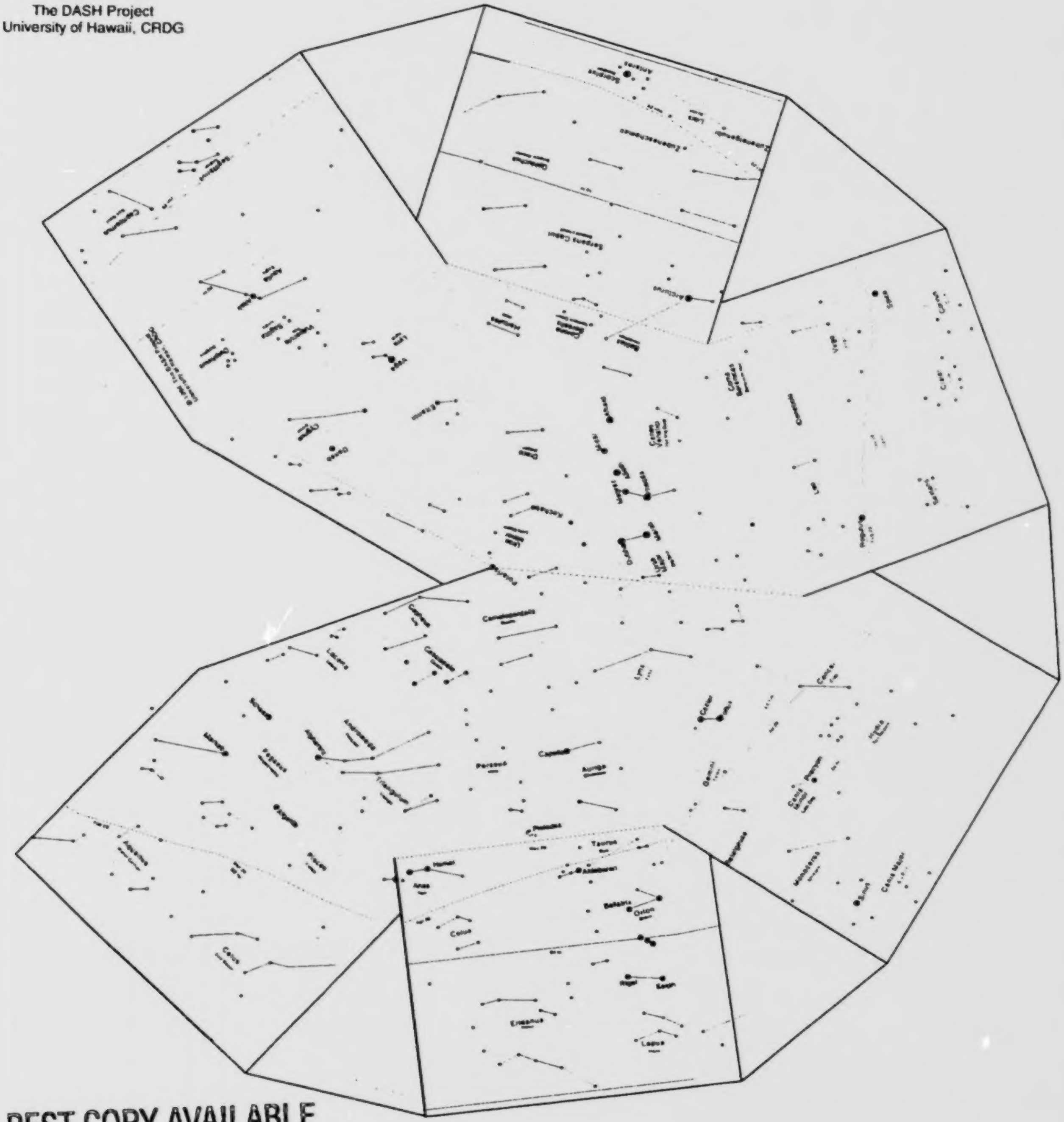
Camelopardalis
Lynx
Cancer
Hydra
Castor
Pollux
Capella
Perseus
Auriga
Gemini
Procyon
Canis Minor
Pleiades
Taurus
Hamal
Aries
Aldebaran
Bellatrix
Orion
Cetus
Rigel
Saiph
Eridanus
Lepus
Monoceros
Sirius
Canis Major

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DASH

Name________________________

Date________________________

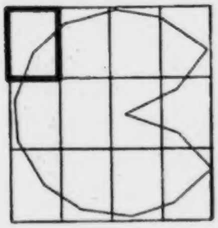
STUDENT PAGE 4.2.17B LARGE PLANETARIUM

Make a large model of the planetarium for the classroom. Use your personal model as a guide to assembling the large model.

- Glue the inside and outside together so that the same stars are directly on top of each other.
- Check the alignment by pressing a pin through 3 or 4 stars. If they are properly aligned, the pin will go through the same star on either side of the model.
- Cut out the planetarium along the heavy lines.
- Fold the planetarium into a six-sided tent using the dotted fold lines.
- Glue or tape the tabs between the two layers of the planetarium. If tape is used, the planetarium can be disassembled, folded flat, and stored.

CUT ALONG INSIDE OF DOTTED LINE

DASH—IN



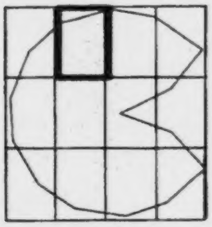
12 pages

216

Corvus
Crow
Spica

GLUE EDGE

CUT ALONG INSIDE OF DOTTED LINE



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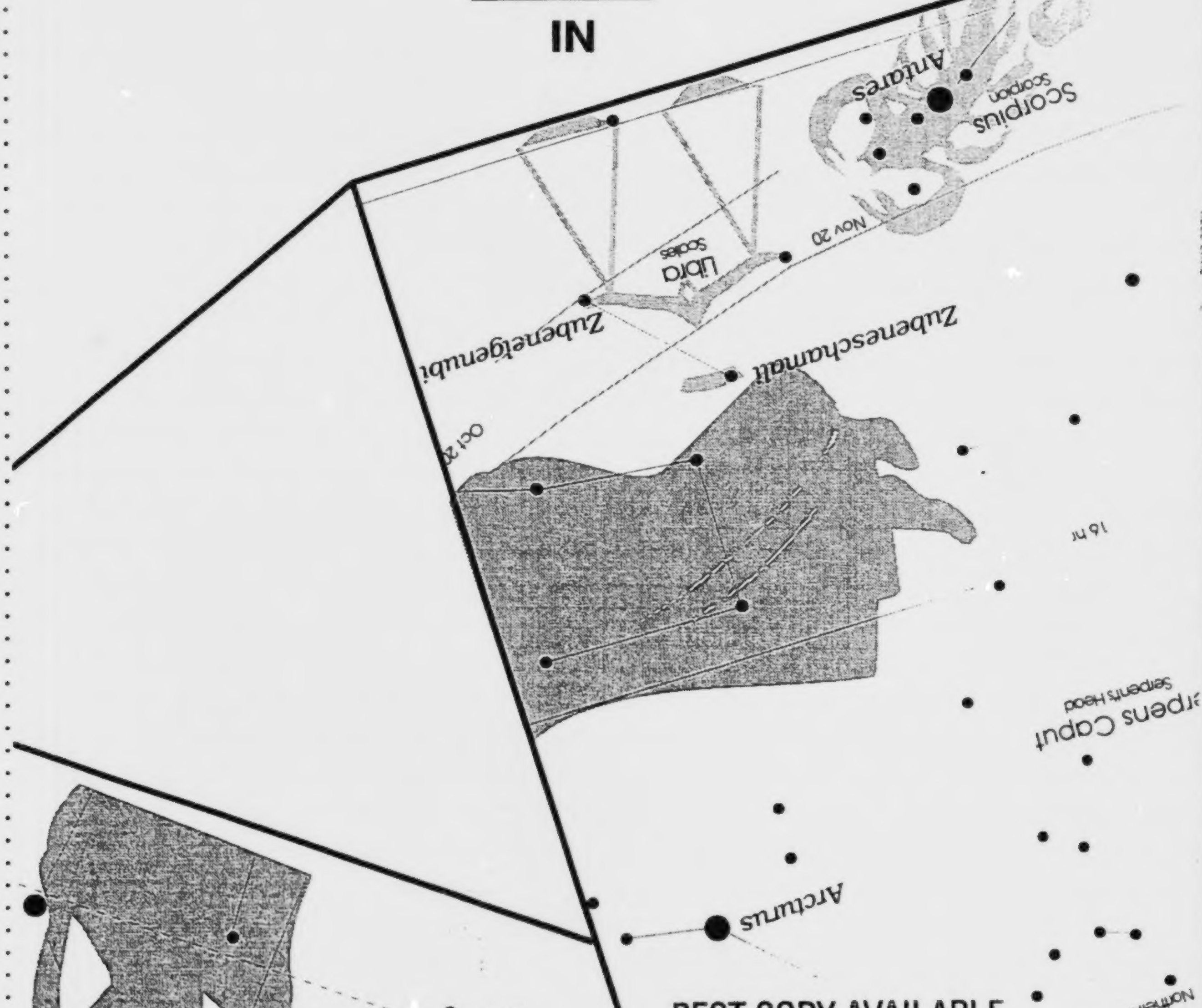
Antares
Scorpius
Scorpion
Libra
Scales
Nov 20
Zubenelgenubi
Zubeneschamali
Oct 20
16 hr
erpens Caput
Serpent's Head
Arcturus
Borealis
Northern Crown

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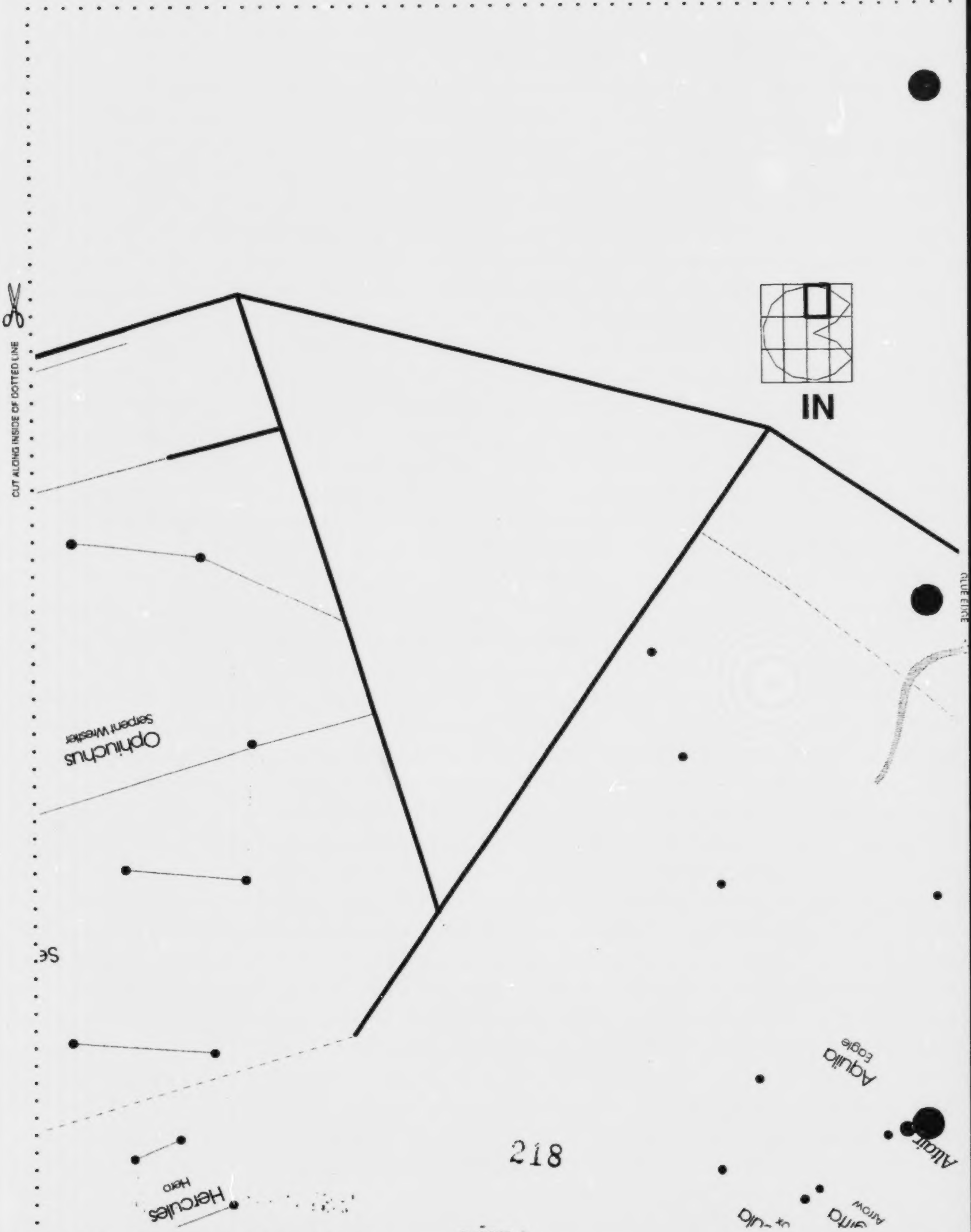
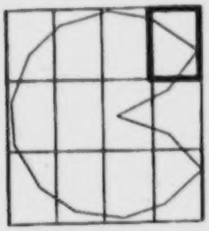
GLUE EDGE


CUT ALONG INSIDE OF DOTTED LINE
IN
GLUE EDGE
Ophiuchus
Serpent Wrestler
Se
Aquila
Eagle
Altair
Hercules
Hero
Sagitta
Arrow
GLUE EDGE

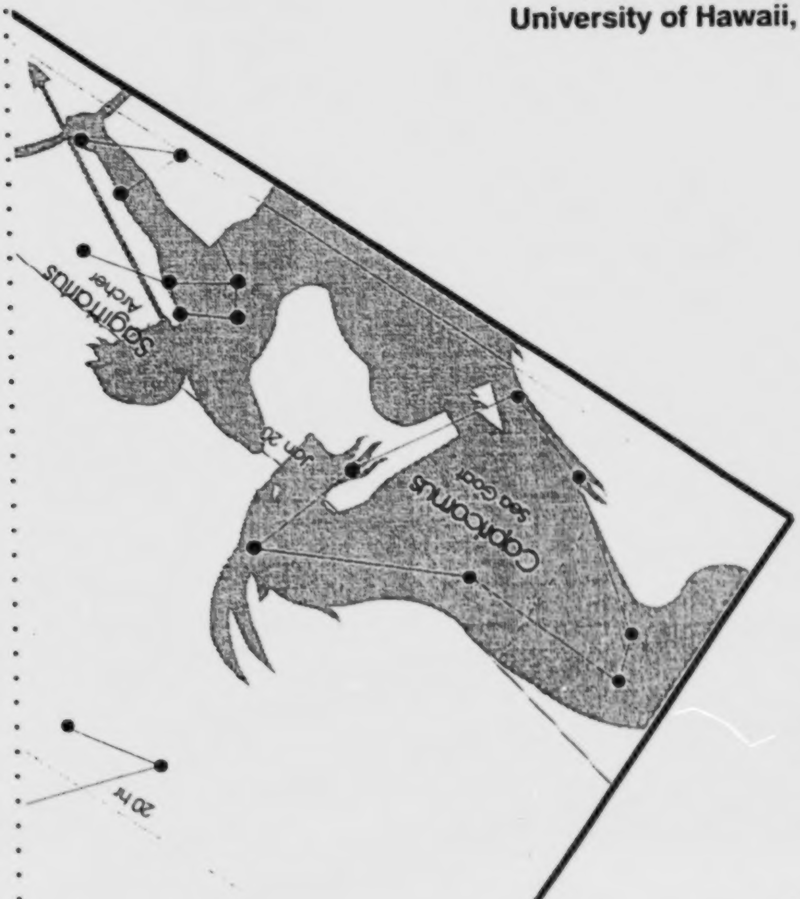
CUT ALONG INSIDE OF DOTTED LINE

DASH—IN



12 pages

The DASH Project
University of Hawaii, CRDG


Sagittarius
Archer
Jan 20
Capricornus
Sea Goat
20 hr

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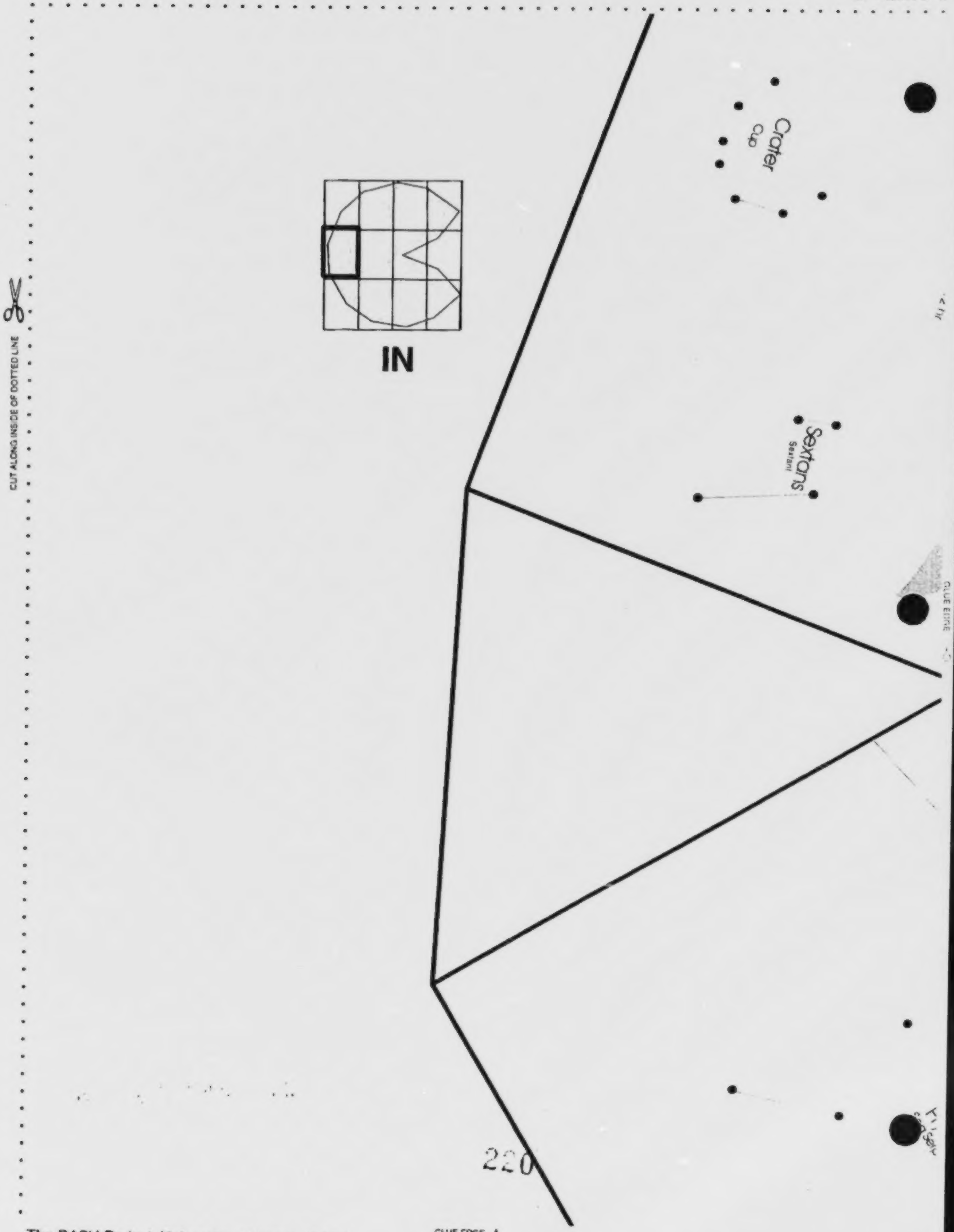
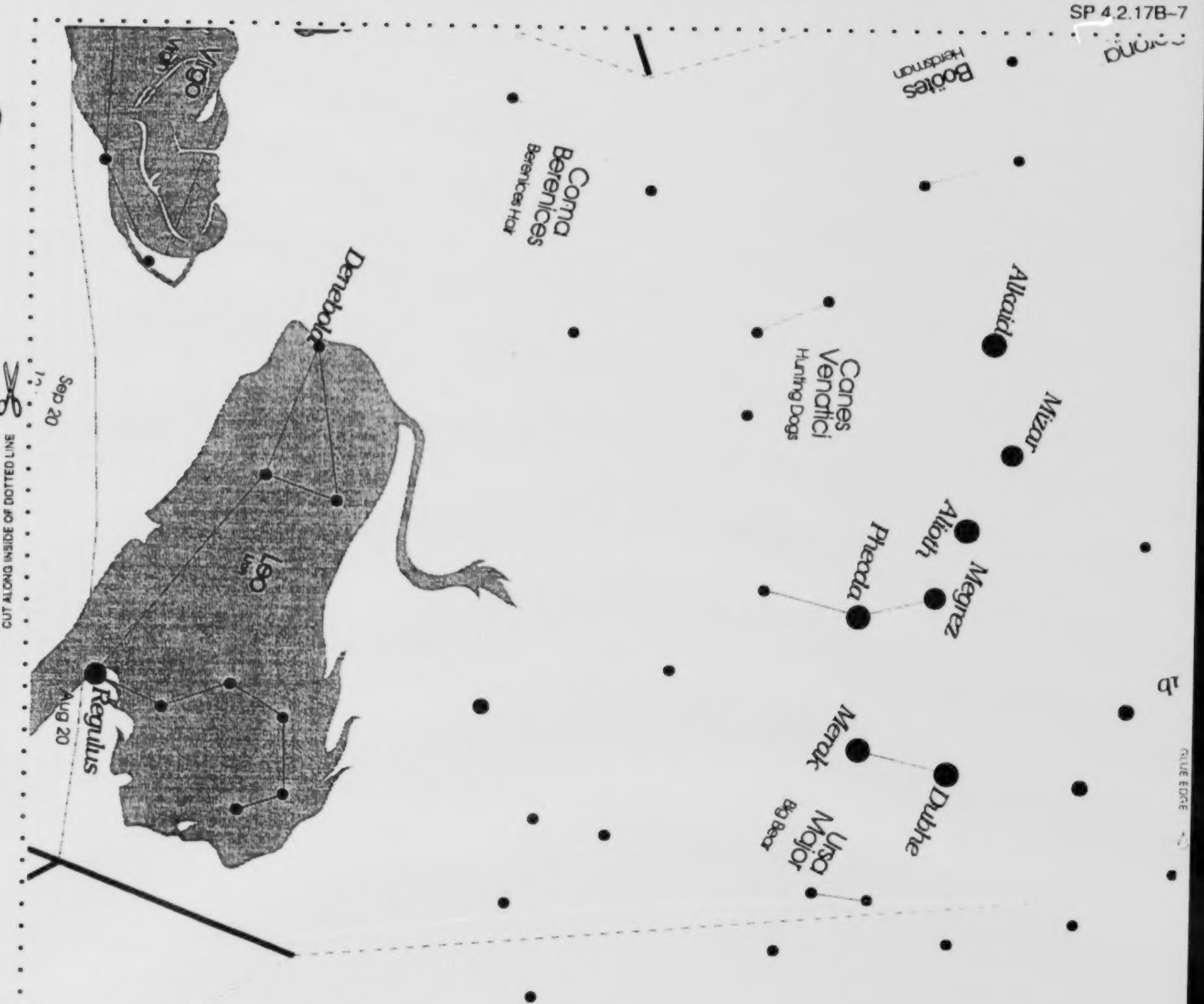
GLUE EDGE


CUT ALONG INSIDE OF DOTTED LINE
IN
Crater
Cup
Sextans
Sextant
GLUE EDGE
GLUE EDGE


Virgo
Coma
Berenices
Berenices Hair
Boötes
Herdsman
Denebola
Alkaid
Canes
Venatici
Hunting Dogs
Mizar
Sep 20
CUT ALONG INSIDE OF DOTTED LINE
Leo
Lion
Alioth
Megrez
Phecda
Regulus
Aug 20
Merak
Dubhe
Ursa
Major
Big Bear
GLUE EDGE
Cancer
Crab
Lynx
Lynx
Jun 20
Jul 20
Pollux
Castor
Hydra
Pro
Ca
GLUE EDGE

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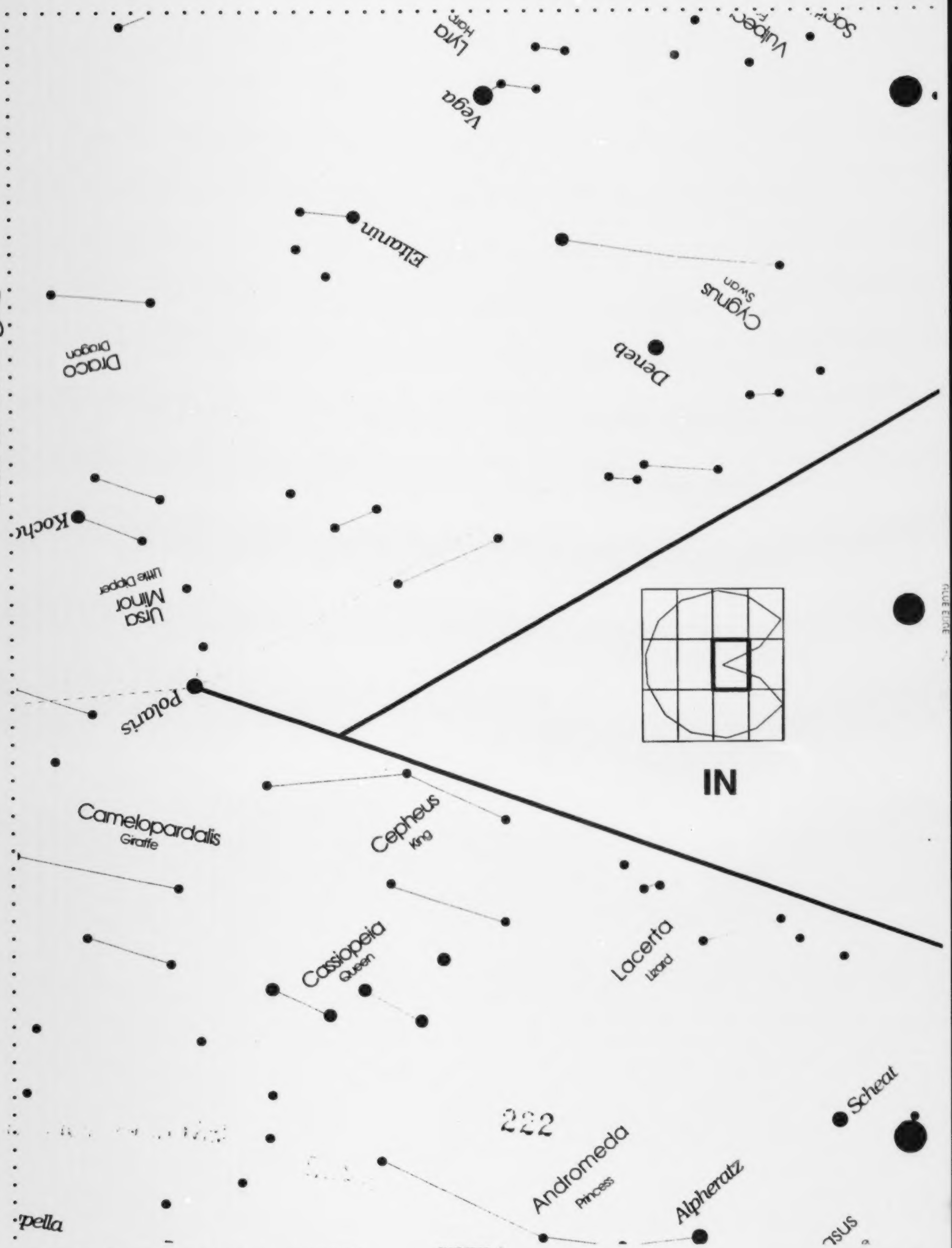
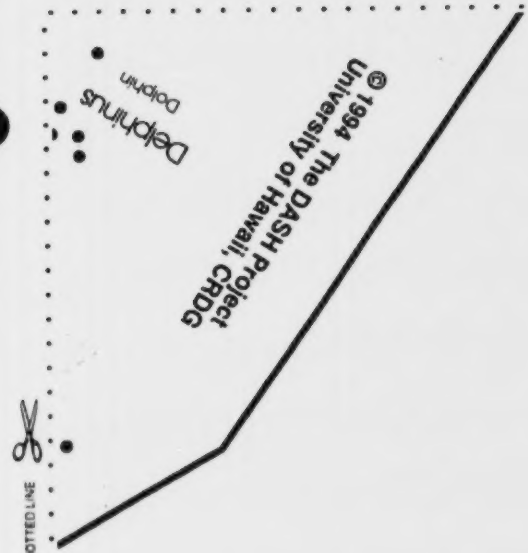

Lyra
Harp
Vega
Vulpec
F
Sag
Eltanin
Cygnus
Swan
Draco
Dragon
Deneb
Koch
Ursa
Minor
Little Dipper
Polaris
IN
Camelopardalis
Giraffe
Cepheus
King
Cassiopeia
Queen
Lacerta
Lizard
Andromeda
Princess
Alpheratz
Scheat
pella
SUS

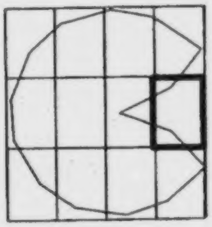
CUT ALONG INSIDE OF DOTTED LINE

GLUE EDGE

GLUE EDGE


Delphinus
Dolphin

CUT ALONG INSIDE OF DOTTED LINE



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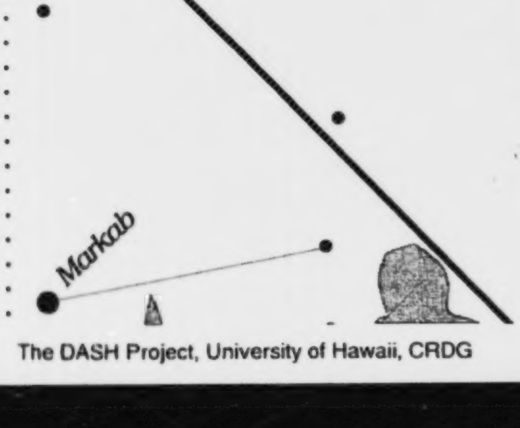
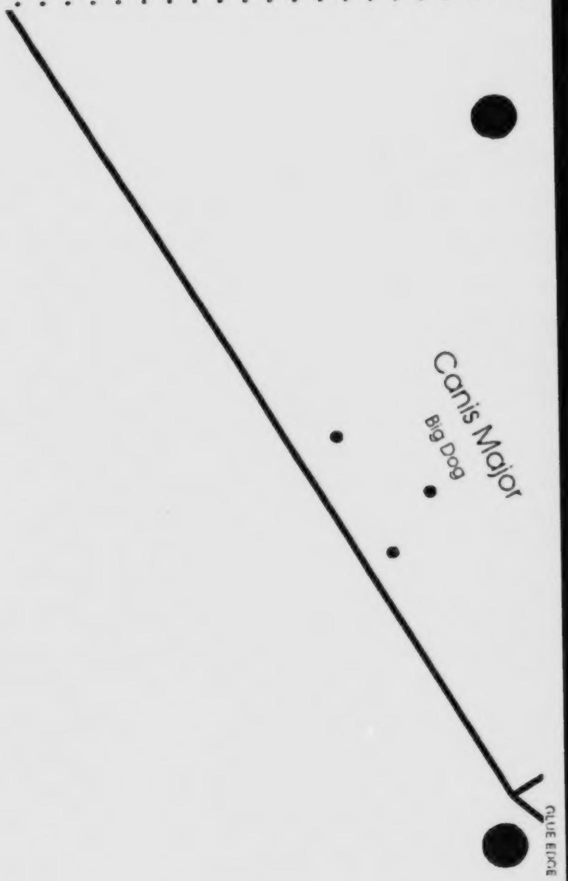
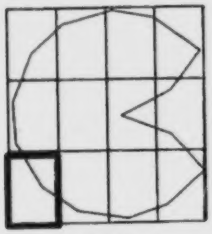
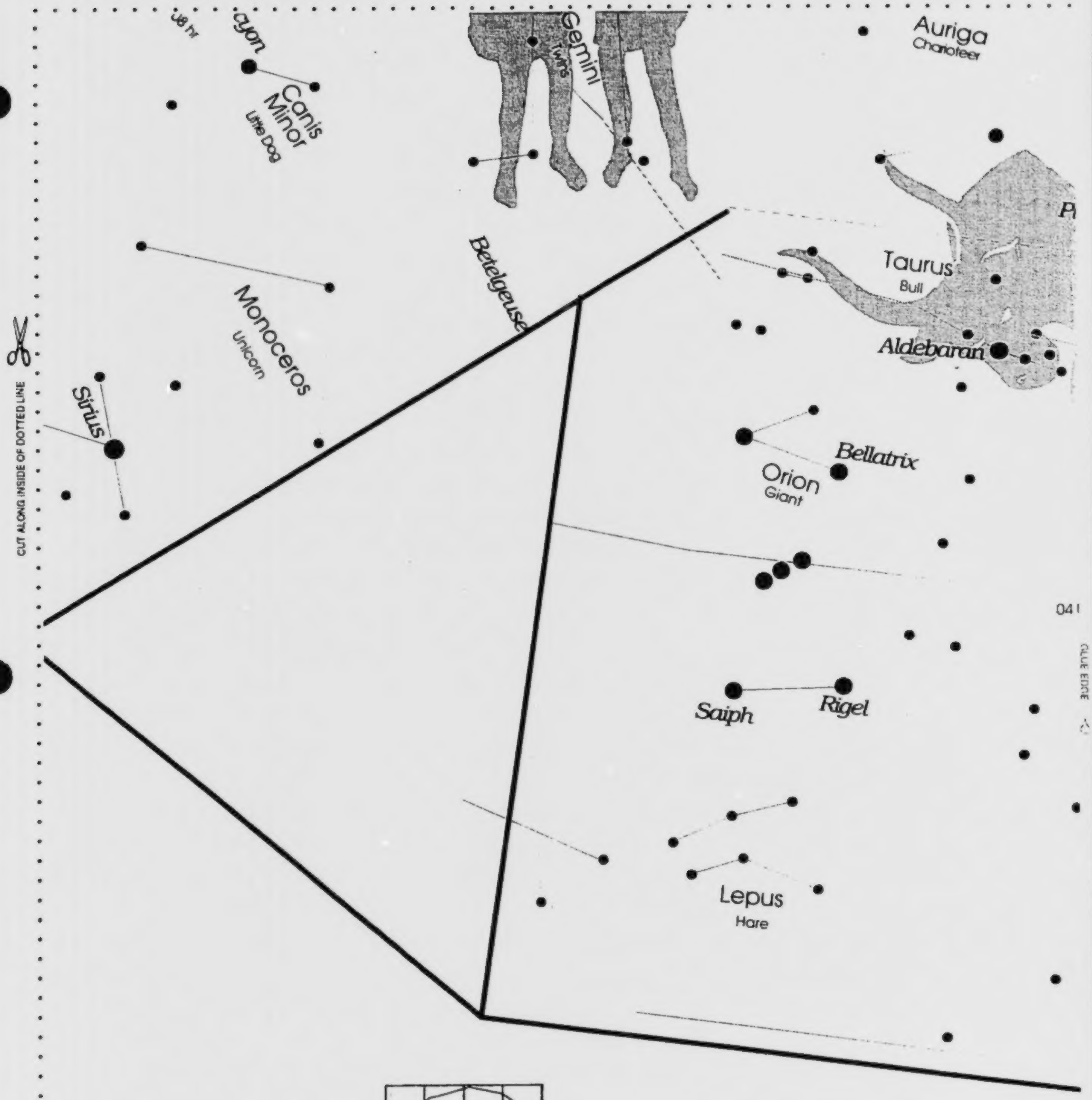


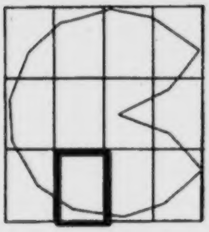
GLUE EDGE

CUT ALONG INSIDE OF DOTTED LINE


Canis Major
Big Dog
GLUE EDGE




Auriga
Charioteer
Gemini
Twins
cyon
Canis Minor
Little Dog
Monoceros
Unicorn
Betelgeuse
Sirius
Taurus
Bull
Aldebaran
Pl
Bellatrix
Orion
Giant
Saiph
Rigel
Lepus
Hare
04 h
CUT ALONG INSIDE OF DOTTED LINE
GLUE EDGE



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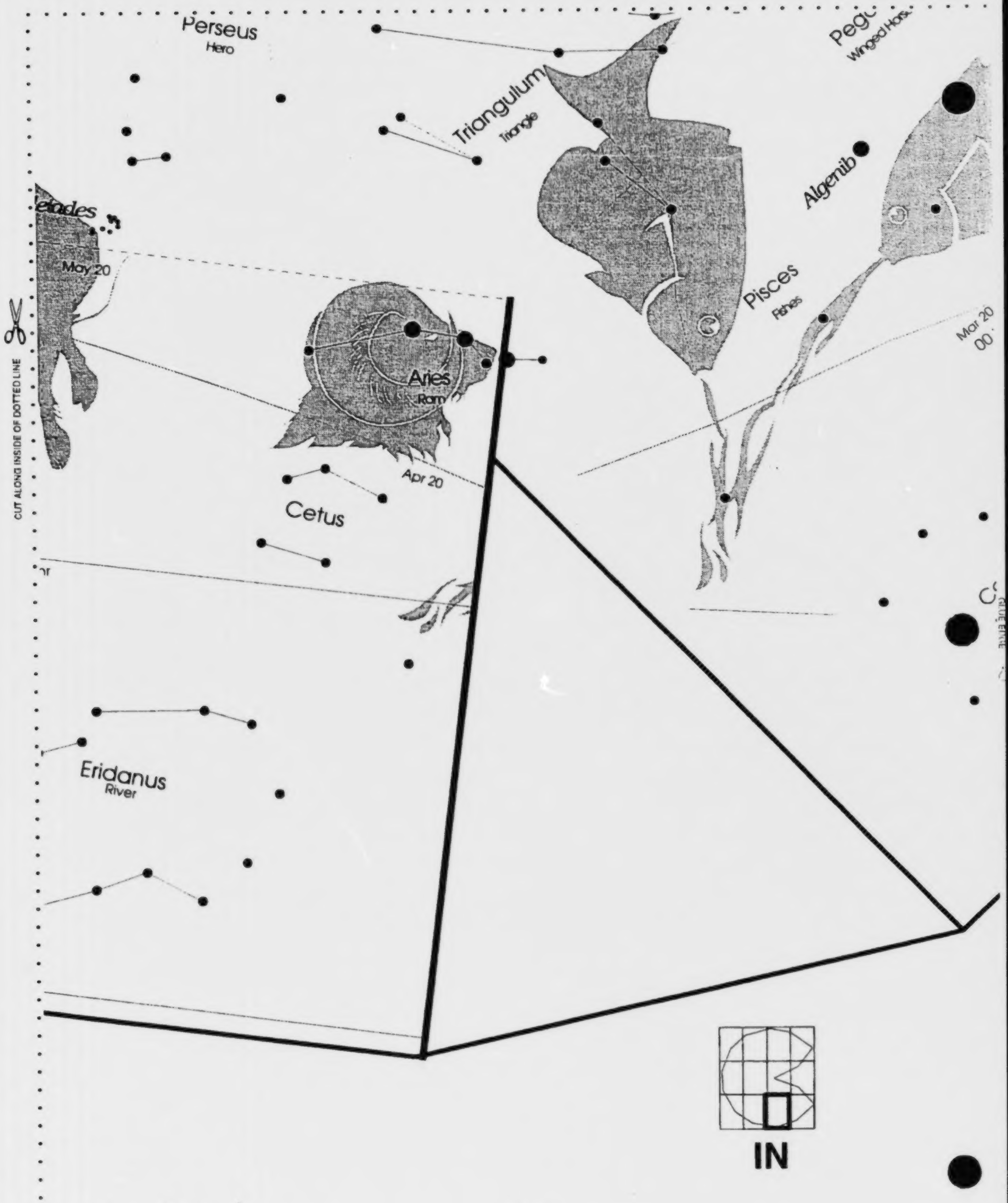
Perseus
Hero
Triangulum
Triangle
Pegc
Winged Hors
eiades
May 20
Aries
Ram
Apr 20
Cetus
Pisces
Fishes
Algenib
Mar 20
00
Eridanus
River
CUT ALONG INSIDE OF DOTTED LINE
GLUE LINE
IN

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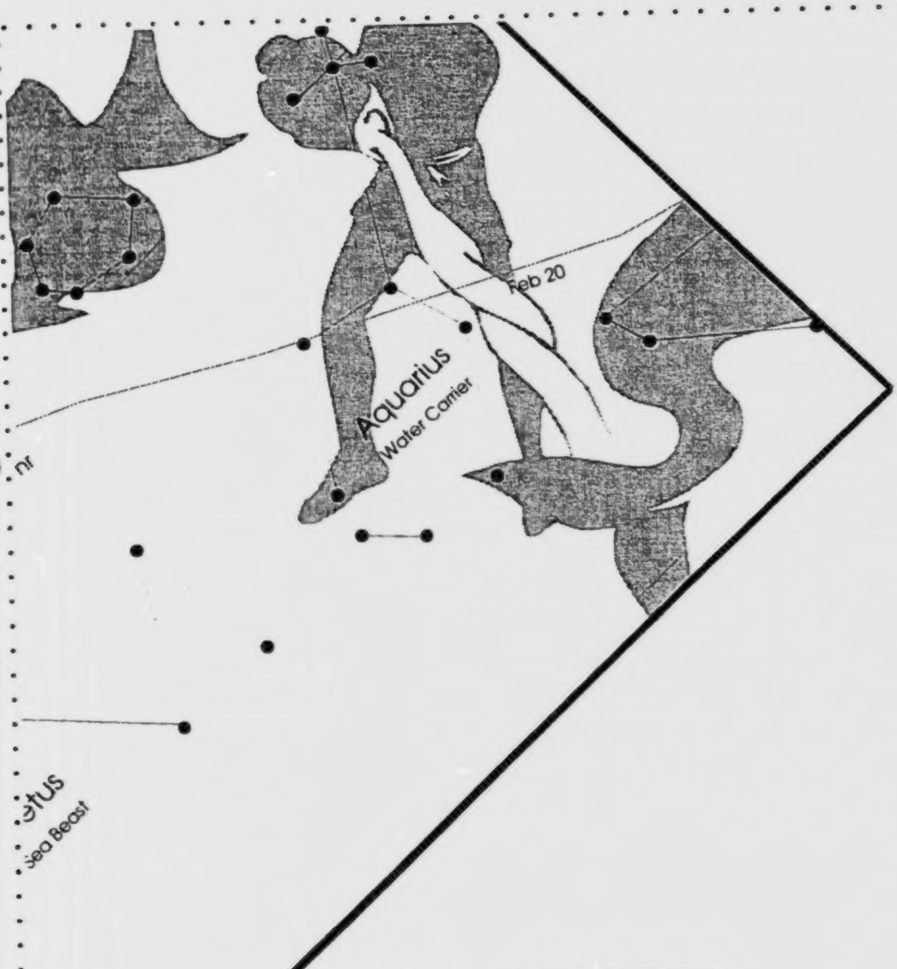
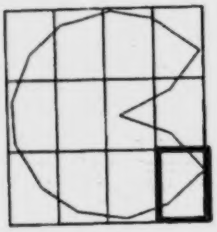
CUT ALONG INSIDE OF DOTTED LINE


Aquarius
Water Carrier
Feb 20
nr
etus
Sea Beast

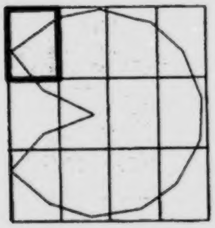


IN

BEST COPY AVAILABLE

CUT ALONG INSIDE OF DOTTED LINE

DASH—OUT



12 pages

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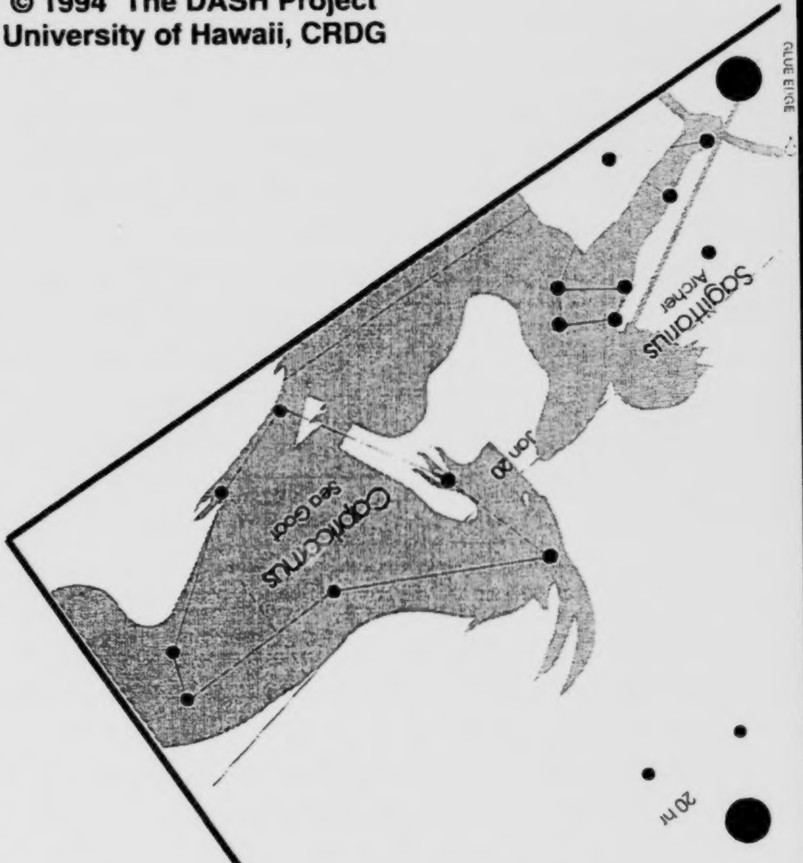
GLUE EDGE
Sagittarius
Archer
Jan 30
Capricornus
Sea Goat
20 hr

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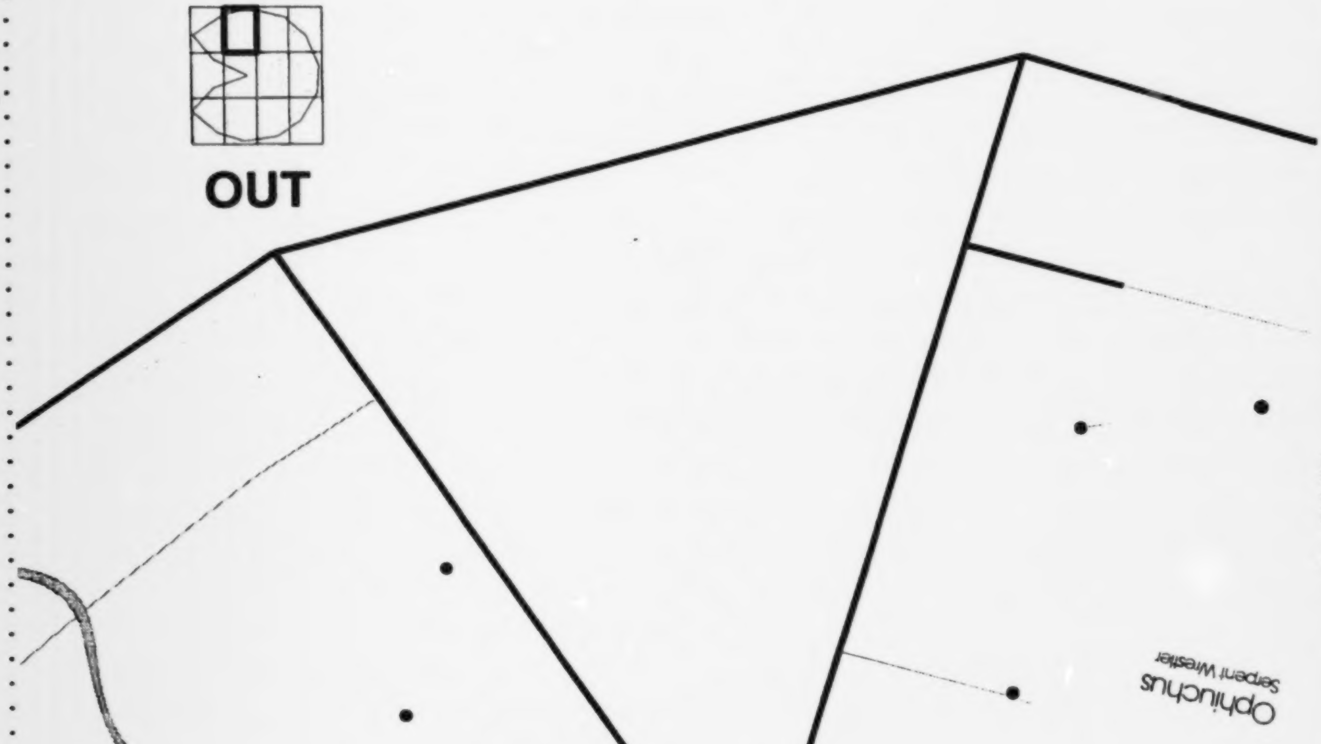
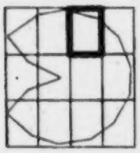
GLUE EDGE

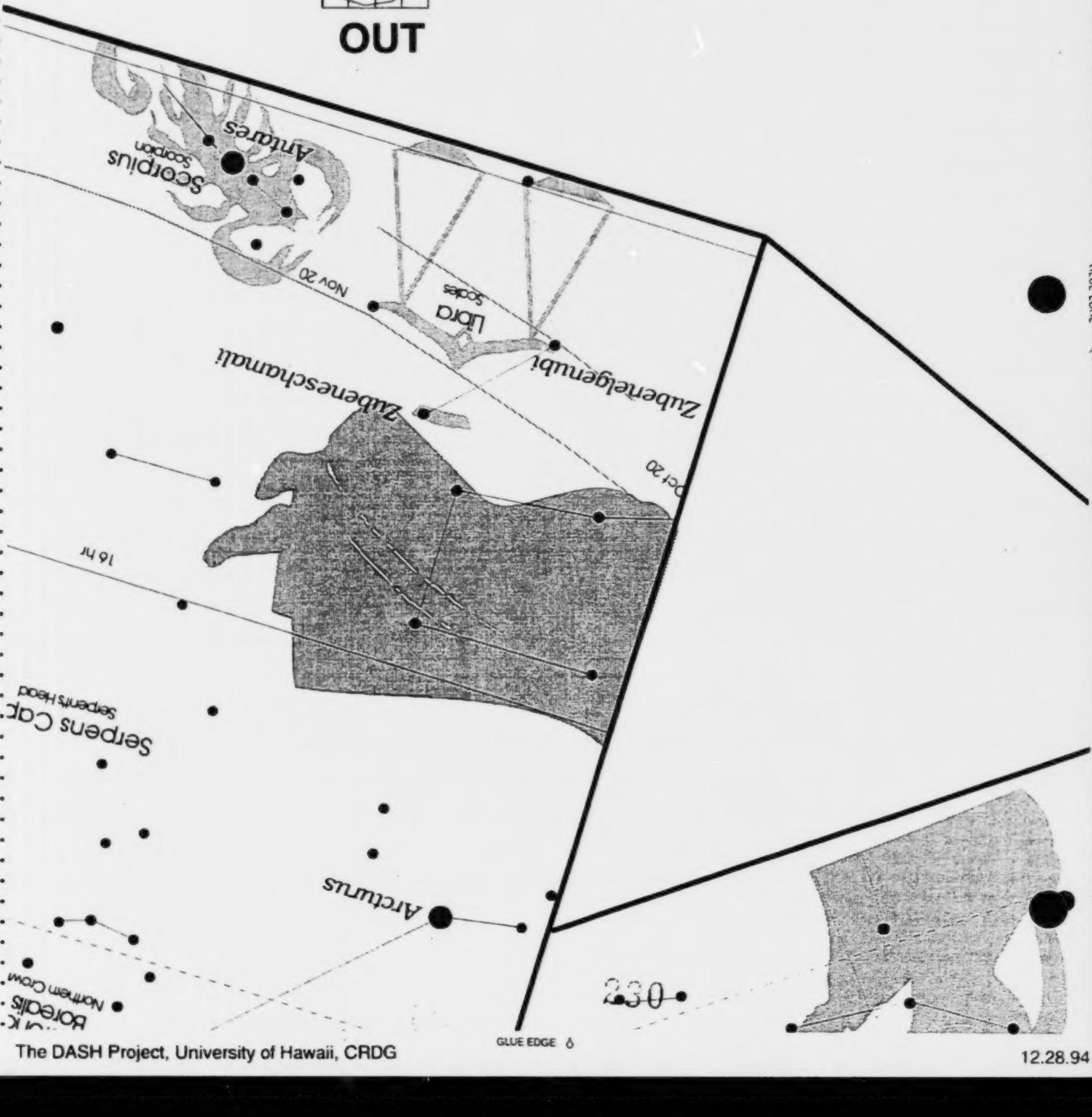
CUT ALONG INSIDE OF DOTTED LINE


OUT
GLUE EDGE
Ophiuchus
Serpent Wrestler
Aquila
Eagle
Altair
Sag
Arrow
Hercules
Hero
GLUE EDGE

CUT ALONG INSIDE OF DOTTED LINE



OUT


Scorpius
Scorpion
Antares
Nov 20
Libra
Scales
Zubenelgenubi
Zubeneschamali
Oct 20
16 hr
Serpens Cap
Serpent's Head
Arcturus
Northern Crown
Borealis
GLUE EDGE

230

GLUE EDGE

CUT ALONG INSIDE OF DOTTED LINE

DASH—OUT

12 pages

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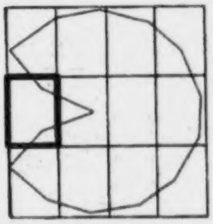
Spica
Corvus
Crow

GLUE EDGE

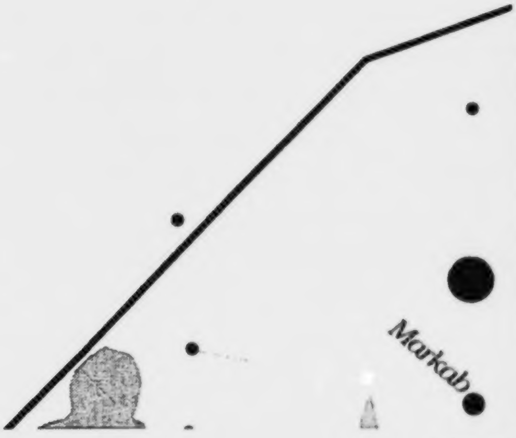
Delphinus
Dolphin

CUT ALONG INSIDE OF DOTTED LINE



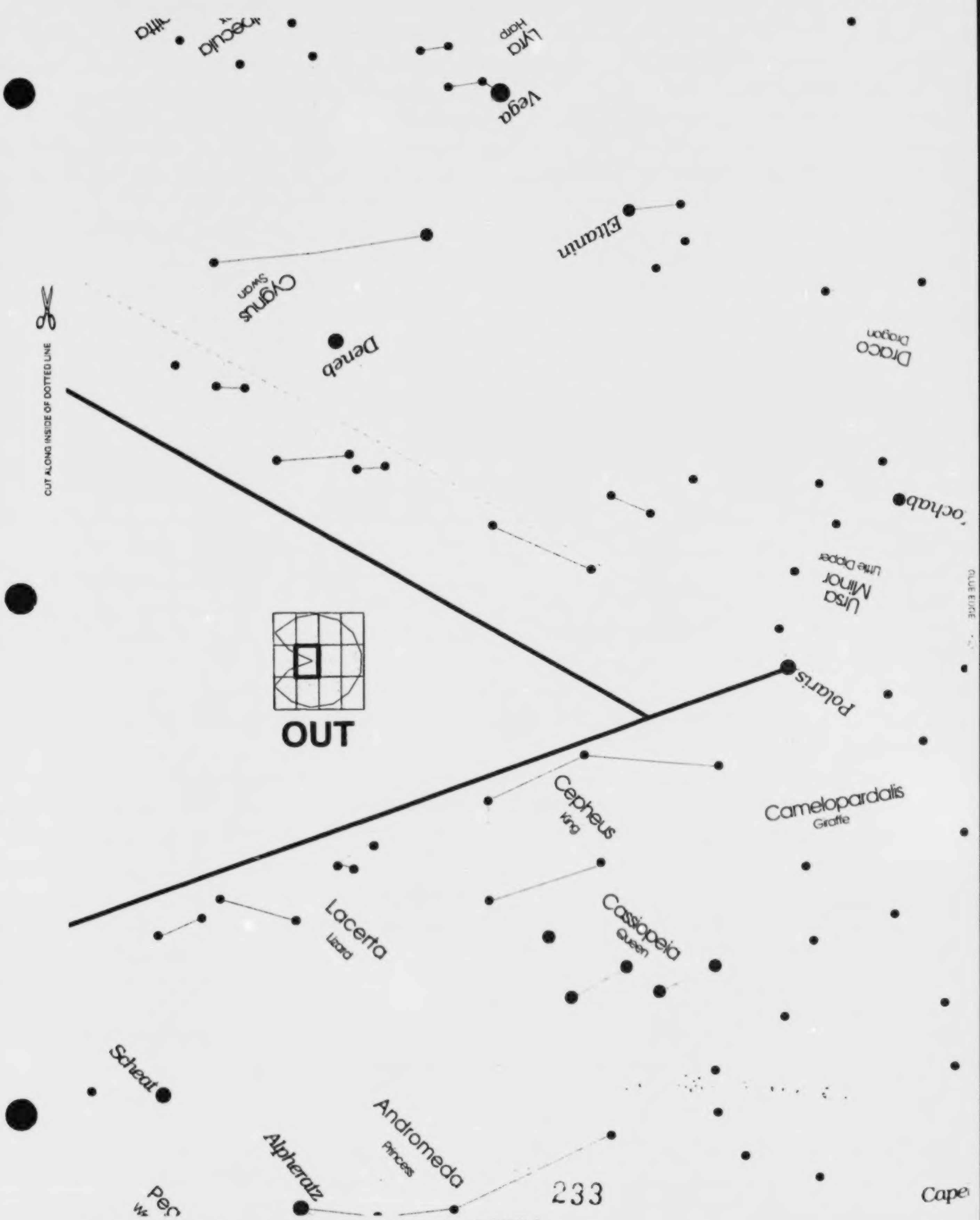
OUT

GLUE EDGE

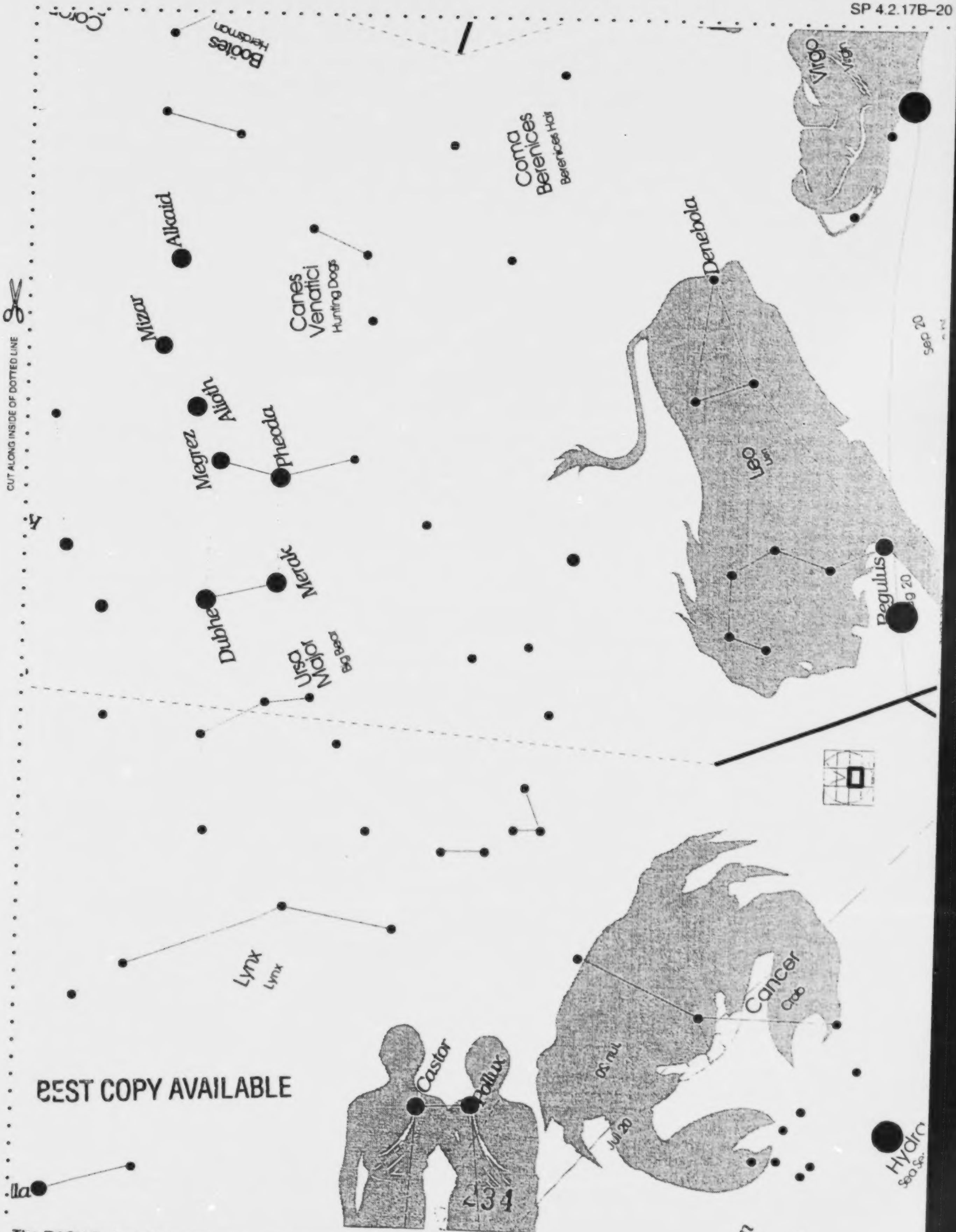


232

GLUE EDGE


Lyra
Harp
Vega
Eltanin
Cygnus
Swan
Deneb
Draco
Dragon
ochab
Ursa
Minor
Little Dipper
Polaris
Cepheus
King
Camelopardalis
Giraffe
Lacerta
Lizard
Cassiopeia
Queen
Scheat
Andromeda
Princess
Alpheratz
Pe
Cape
OUT
CUT ALONG INSIDE OF DOTTED LINE
GLUE EDGE
GLUE EDGE

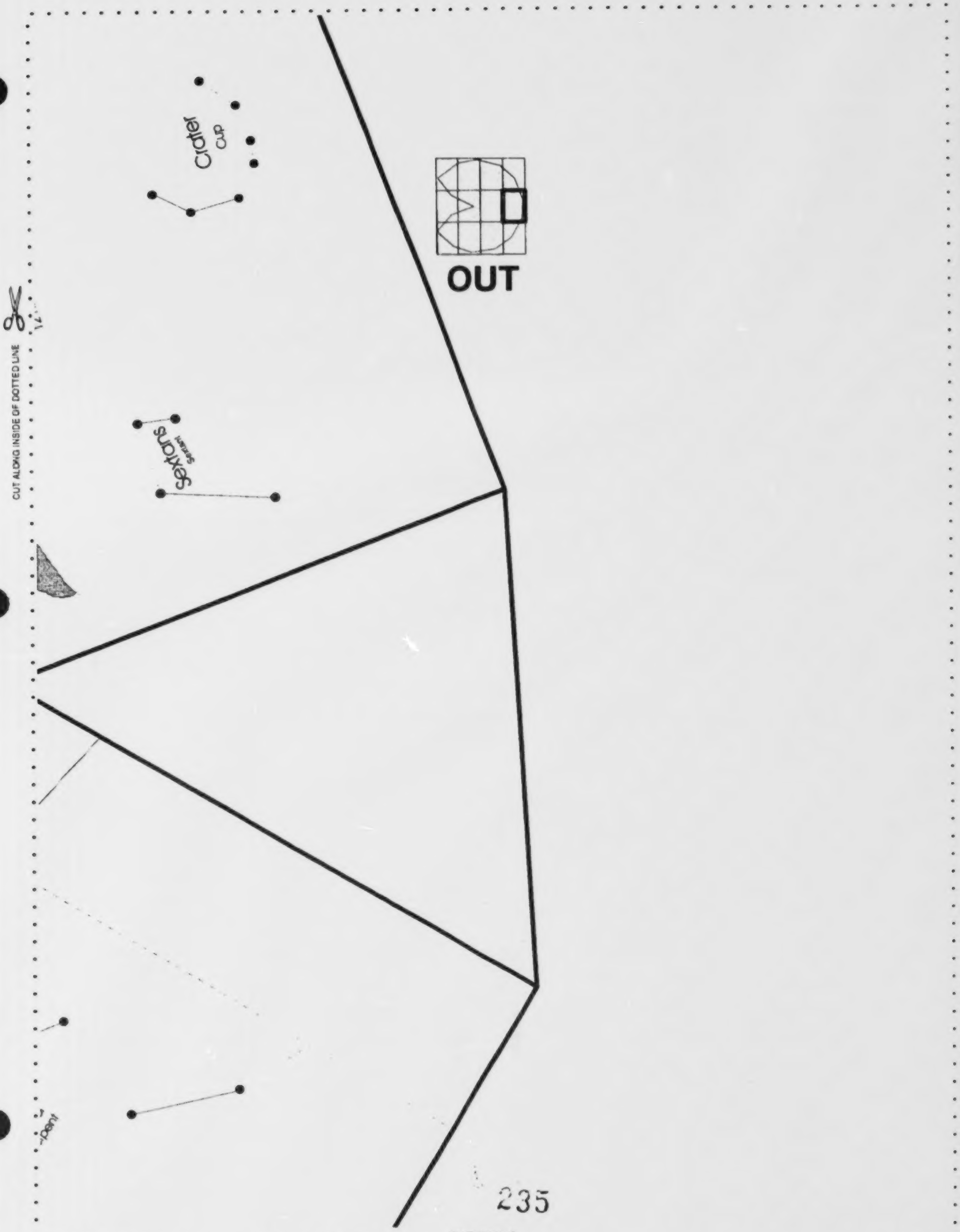
233


CUT ALONG INSIDE OF DOTTED LINE
Coro
Boötes
Herdsman
Coma
Berenices
Berenices Hair
Virgo
Virgin
Alkaid
Mizar
Canes
Venatici
Hunting Dogs
Alioth
Megrez
Phecda
Denebola
Leo
Lion
Sep 20
Dubhe
Merak
Ursa
Major
Big Bear
Regulus
Aug 20
Lynx
Lynx
Cancer
Crab
Castor
Pollux
Jun 20
Jul 20
Hydra
Sea Se
lla

BEST COPY AVAILABLE

GLUE EDGE

The DASH Project, University of Hawaii, CRDG


Crater
Cup
OUT
CUT ALONG INSIDE OF DOTTED LINE
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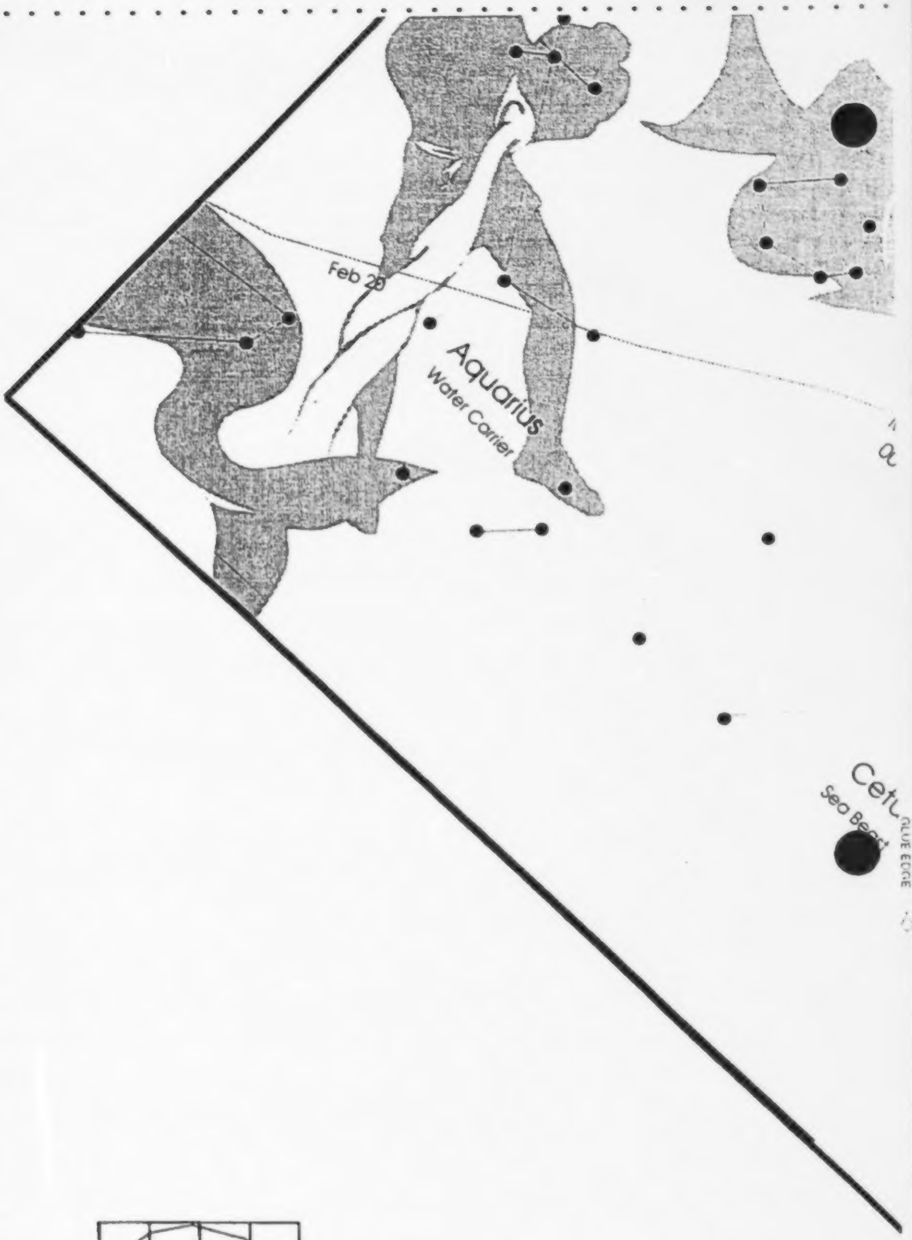
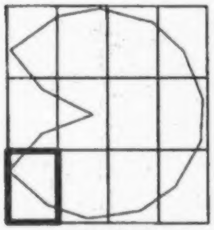
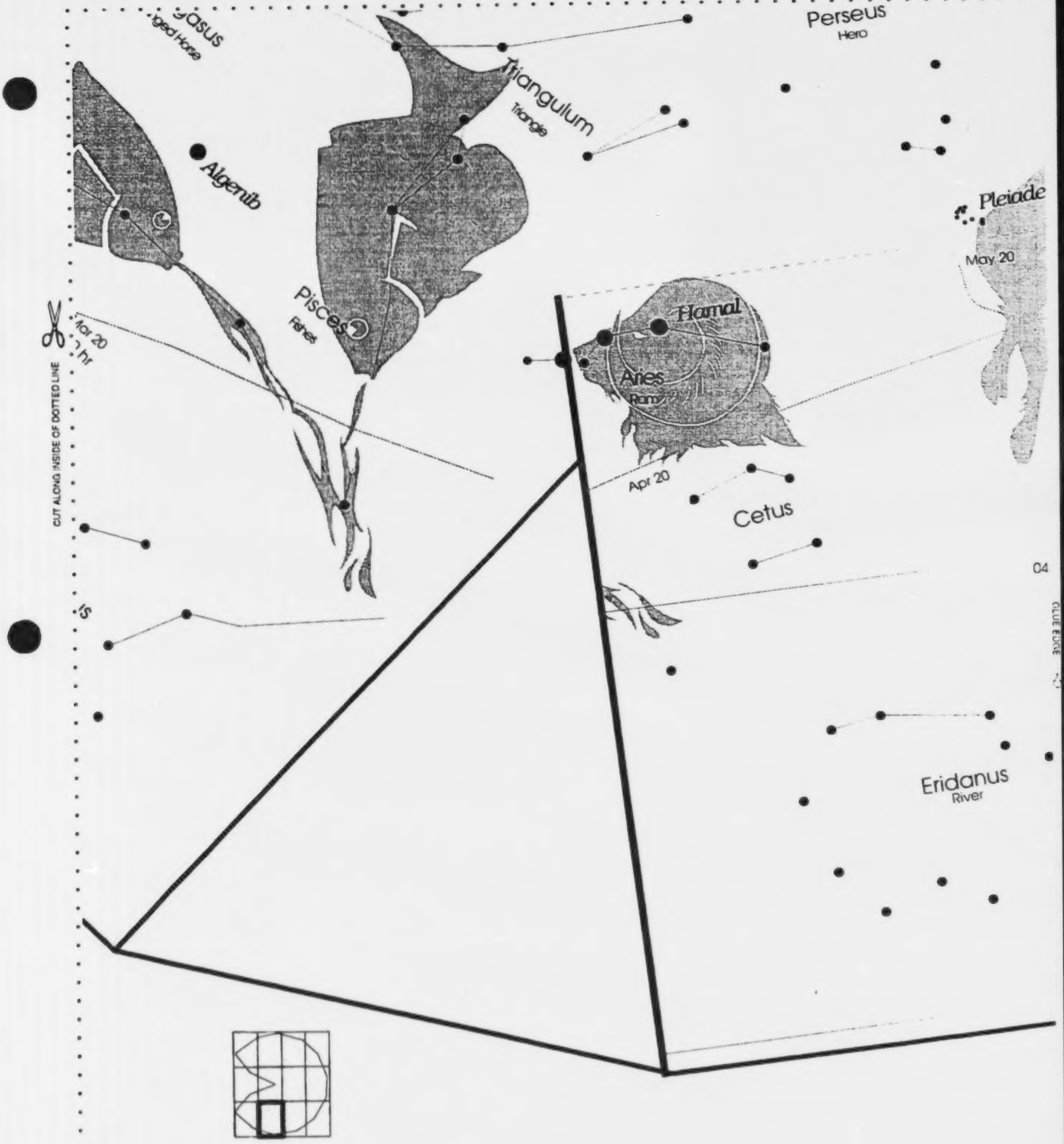
-pent
GLUE EDGE 6

CUT ALONG INSIDE OF DOTTED LINE


Feb 20
Aquarius
Water Carrier
α
Cetu
Sea Beast
GLUE EDGE



OUT


CUT ALONG INSIDE OF DOTTED LINE
gasus
ged Horse
Perseus
Hero
Triangulum
Triangle
Algenib
Pleiade
May 20
Pisces
Fishes
ar 20
hr
Hamal
Aries
Ram
Apr 20
Cetus
04
GLUE EDGE
is
Eridanus
River
OUT

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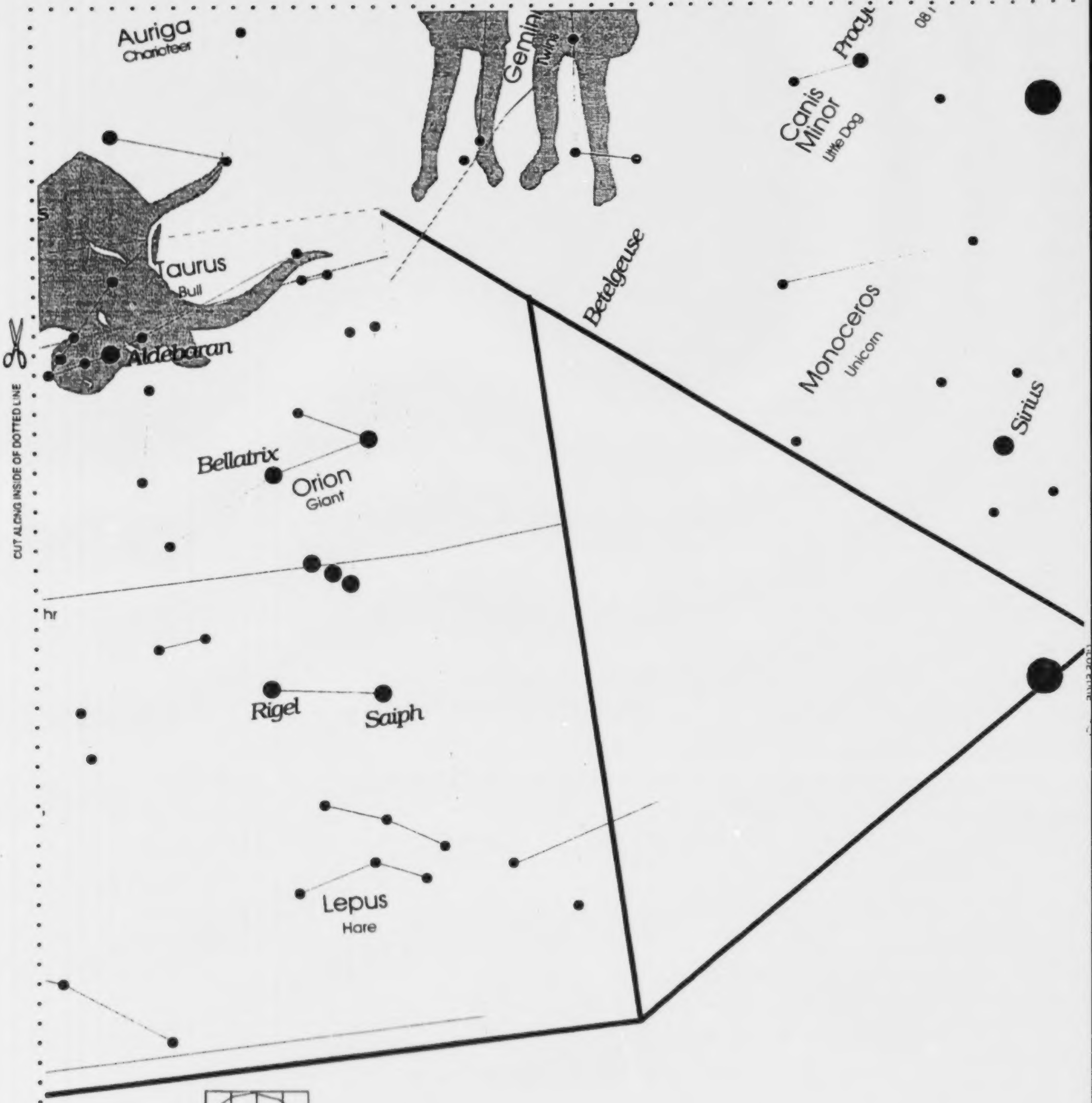
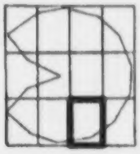
237

CUT ALONG INSIDE OF DOTTED LINE


Auriga
Charioteer
Gemini
Twins
Procy
Canis Minor
Little Dog
Taurus
Bull
Aldebaran
Betelgeuse
Monoceros
Unicorn
Sirius
Bellatrix
Orion
Giant
hr
Rigel
Saiph
Lepus
Hare



OUT

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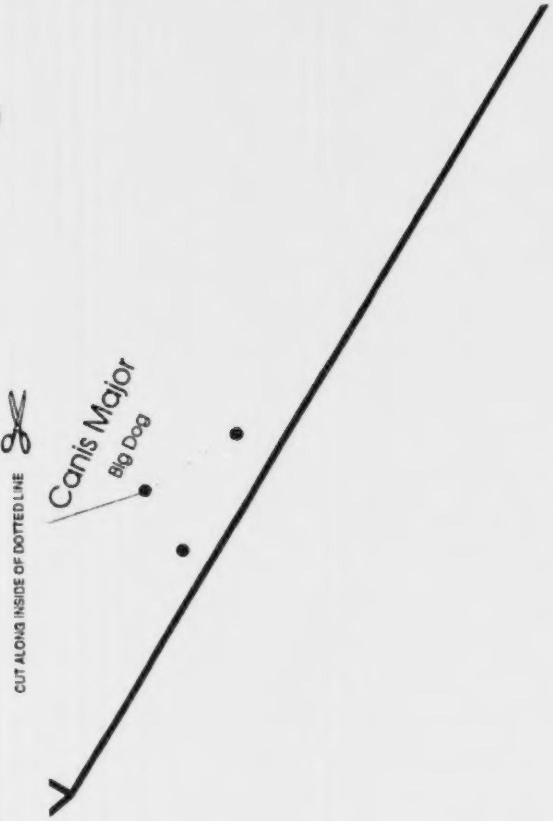

CUT ALONG INSIDE OF DOTTED LINE
Canis Major
Big Dog

OUT

ACTIVITY 4.2.18 USING THE PLANETARIUM

OBJECTIVES

The students
- Use the planetarium to become acquainted with the night sky.
- Use their planetarium to identify bright stars and their organization into constellations.

BACKGROUND

This activity follows Activity 4.2.17 PLANETARIUM in which the students construct planetarium models. In USING THE PLANETARIUM they review what they have learned about the night sky and identify the major zodiacal constellations. Since the activity is to be done at home, it is suggested a letter be sent to the parents before its introduction. This activity should be done before Activities 4.2.19 PLANETS and 4.2.21 MAKING A SUNDIAL.

When To View

In the fall, winter, and early spring two sightings, one in the evening after twilight and one before the early light of daybreak, will give a view of most of the constellations in the zodiac except the one directly behind the sun.

When To Start the Activity

It is suggested that the activity be started in good weather in the early fall or spring when the nights are reasonably clear, long, and warm. Best viewing will be when the moon is not in the sky. Poorest viewing will be when it is cloudy, the moon is out, or it is smoggy. In many places it will be difficult to see the fainter stars of a constellation. The students should keep this in mind and look for stars with the general location found on the planetarium. Many of the stars shown on the planetarium are faint and will be difficult to see even when visibility is good.

The sun will pass in front of a different constellation of the zodiac each month. We say that the sun is “in the direction of,” or just "in" this constellation. Table 4.2.18 shows when the sun enters or starts to pass in front of constellations of the zodiac. The sun leaves one constellation to enter another.

Table 4.2.18 Location of the sun in the zodiac

Constellation Names in Zodiacal Order	*When Sun Enters Constellation
Capricornus, the Goat	January 19
Aquarius, the Water Bearer	February 16
Pisces, the Fishes	March 12
Aries, the Ram	April 19
Taurus, the Bull	May 14
Gemini, the Twins	June 21
Cancer, the Crab	July 20
Leo, the Lion	August 10
Virgo, the Virgin	September 16
Libra, the Balance	October 31
Scorpius, the Scorpion	November 23
Sagittarius, the Archer	December 18

*Adjust for Leap Years

STUDENT ROLE

Astronomer

MATERIALS

Planetarium model of the northern sky from Activity 4.2.17
Student Page 4.2.18 USING THE PLANETARIUM

PRODUCTS

Learning Calendar record
Completed Student Pages

PROCEDURES

1. **Develop the idea that sun can be used as a 24-hour clock. Have the students mark the classroom with the four cardinal points of the compass—North, South, East, and West.**

2. **Have the students lie on their backs, feet oriented to the south, and place the planetariums over their heads.**

   Ask such questions as
   - Where is the horizon? (Get agreement that it is about at floor level.)
   - If the head represented Earth, where would the sun be at noon? (Have them point directly in front of them.)
   - At the equinox where would the sun be at about 0600 hours? (On the eastern horizon.)
   - Where would the sun be at 1800 and 2400 hours? See Figure 4.2.18(1). (Get agreement that the sun would be on the western horizon at 1800 hours and behind the head at 2400 hours.)

3. **Help the students use the planetarium to find constellations in the night sky. Have them practice by going through an in-class orientation.**

   Have them look into the planetarium and
   - Locate the Big Dipper near the top of the planetarium. (Have them note that the two stars on the far edge of the Big Dipper line up with the North Star, which is in the center of the planetarium.)
   - Lie on their backs looking at the ceiling or heavens and again place the large planetarium over their heads. (See Figure 4.2.18(2).)
   - Tilt the planetarium so the peak is pointing to the North Star. (The North Star will be as many degrees above the northern horizon as the number of degrees of latitude; that is, Hawai‘i, 20°; Louisiana, 30°; Pennsylvania, 40°; Washington, 50°, and so forth. Have them use their fists to estimate degrees.)
   - Put a yellow circle over the constellation the sun is in this month. (Figure 4.2.18(3) shows the sun in the direction of Aquarius.)
   - Use the sun as a reference point. Put the zodiacal constellation Aquarius, which is behind the sun, opposite the 1200-hour noon position. The sun will be in front of Aquarius. (Have the students note that at the 1200-hour position the sunlight will block the view of all the constellations they can see inside the planetarium as they look straight forward.)
   - Use the sun and the constellation it is now in as reference points and look at the sky and the planetarium at different times during the night. (See Figure 4.2.18(3) for an example of the February sky at 0600 hours.)

- Turn the planetarium and look at the zodiac in the 1800-hour position and name the constellations. (Work to the observation that only half the zodiacal band will be visible at any one time.)
- Look at the zodiac in the 0600-hour position and name the constellations. (Again help the students see that only half the zodiacal band is visible at any one time.)
- Predict the constellations that will be visible tonight at 2000 hours or 8:00 p.m.

4. **Have the students use their small personal planetariums at home to observe the sky in the evening and morning. Have them use the Big Dipper as a reference point to find the North Star and the zodiacal constellations they predicted would be there.**

   Ask such questions as
   - How did you orient your planetarium?
   - Did anyone find any of the constellations in the sky that are on our model?
   - Can you tell us how you found them?
   - What kinds of problems did you have? (As often as possible allow the students to solve each other's problems. Many of the stars in some of the constellations of the zodiac are faint.)

5. **Have the students complete Student Page 4.2.18 USING THE PLANETARIUM after they have done their observing.**

6. **Each month have the students post constellation data on the Learning Calendar.**

   Have them record
   - The zodiacal constellation the sun is in.
   - The zodiacal constellation closest to the sun just after sunset.
   - The zodiacal constellation closest to the sun just before sunrise.

7. **After several months have the students summarize the their observations and make predictions about the rest of the school year.**

   Ask such questions as
   - What do we mean when we say the sun is in a zodiacal constellation? (Work to the idea that a zodiacal constellation is

not visible in either the night or morning sky because it is in the direction of the sun.)

- How do the constellations of the zodiac move across the sky? (Get agreement that they move from east to west each night and seem to change their position slowly each month, moving one zodiacal constellation farther to the east.)
- What constellation do you predict will appear next month after sunset? (The next in the zodiacal series.)

EXTENSIONS

Have the students

- Predict which constellations they will find to be visible from the North Pole and then do research to check their predictions. (All of those down to the celestial equator. Earth blocks the view of the stars in the Southern Hemisphere.)
- Predict which zodiacal constellations they will find to be visible from the equator and then do research to check their predictions. (All the constellations in the sky can be seen from the equator. The North Star is on the northern horizon; the Southern Cross, 30° above the southern horizon.)

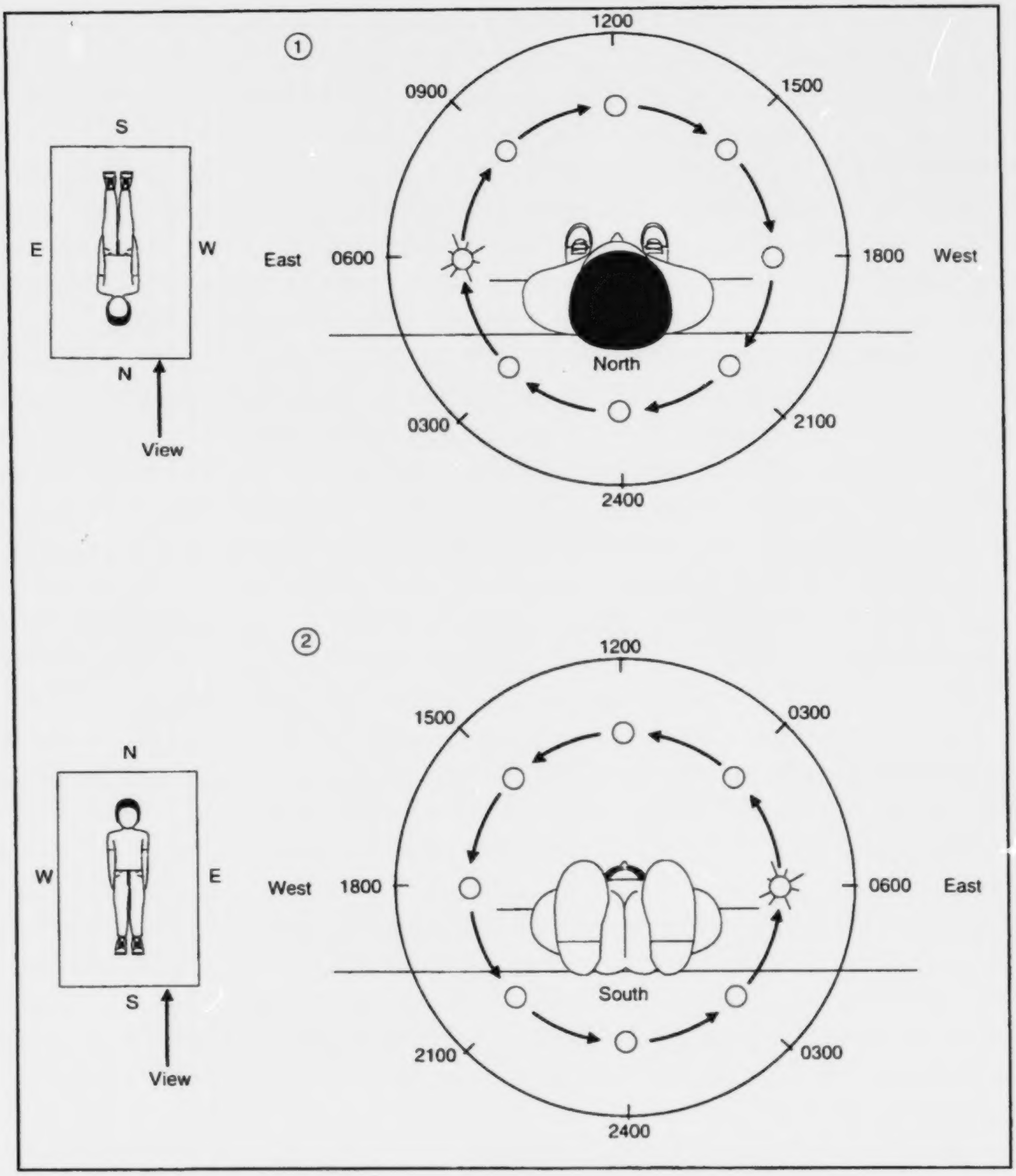

①
S
E
W
N
View
1200
0900
1500
East
0600
1800
West
North
0300
2100
2400
②
N
W
E
S
View
1200
1500
0300
West
1800
0600
East
South
2100
0300
2400

Figure 4.2.18(1) Location of the sun at different hours of the day and night in relation to a head model of Earth. Showing a north-to-south view (**1**) and a south-to-north view (**2**).

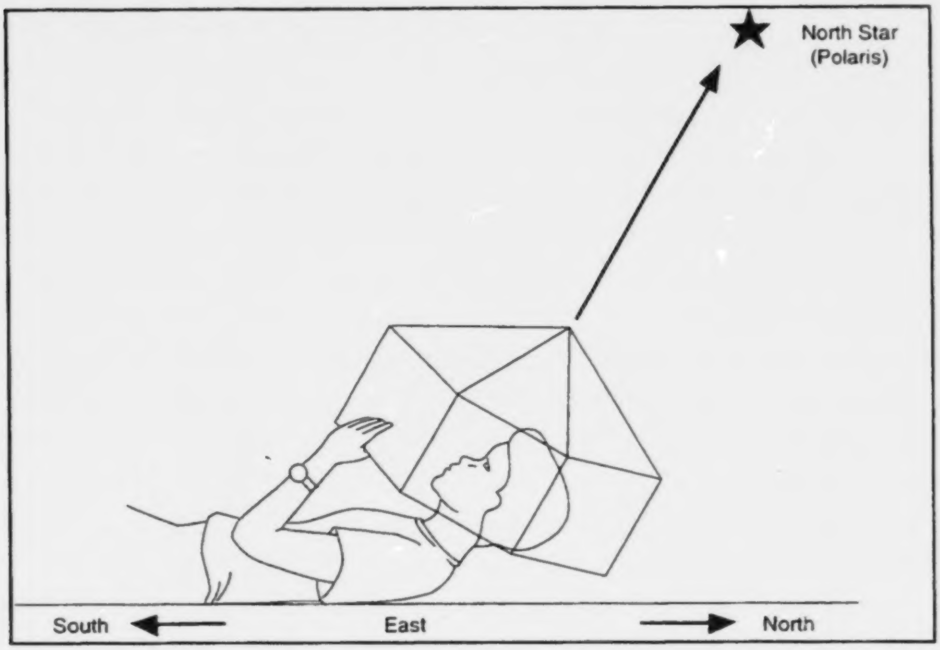

North Star
(Polaris)
South
East
North

Figure 4.2.18(2) Orienting the planetarium

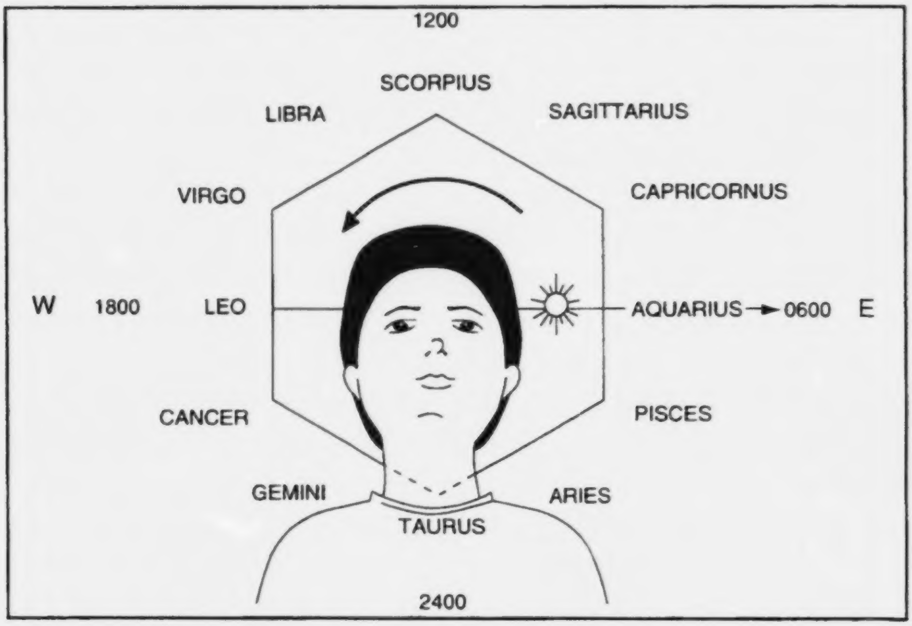

1200
SCORPIUS
LIBRA
SAGITTARIUS
VIRGO
CAPRICORNUS
W
1800
LEO
AQUARIUS
0600
E
CANCER
PISCES
GEMINI
ARIES
TAURUS
2400

Figure 4.2.18(3) Location of the constellations of the zodiac at 0600 hours when the sun is in Aquarius between February 14 and March 24

Name______________________

Date______________________

DASH

STUDENT PAGE 4.2.18 USING THE PLANETARIUM

1. Describe how you found the North Star.

____

____

____

____

____

2. Draw the stars in the constellation of the zodiac you expect to find nearest the western horizon after sunset. Connect the constellation's stars with lines as they are shown on the planetarium. Use an (X) to mark the ones you can find.

OCTOBER

NOVEMBER

DECEMBER

JANUARY

FEBRUARY

MARCH

APRIL

MAY

ACTIVITY 4.2.19 PLANETS

OBJECTIVES

The students
- Use their planetariums to locate the planets.
- Follow the planets' path through the zodiac.
- Make a planet finder.

BACKGROUND

In this activity the planets that can be seen with the naked eye are observed and their paths through the zodiacal constellations are recorded. These planets are the bright Venus, Mars, Jupiter, and the dimmer Saturn and Mercury. Mercury is difficult to see because it is usually very near the sun. This activity follows Activity 4.2.18 USING THE PLANETARIUM.

When To View

Planets as well as constellations are not visible all the time. However, when they are, they can be seen in the evening or before daybreak. Most students should be able to make their observations without disrupting home activities. Sometimes Mars, Jupiter, and Saturn will be visible throughout the night. The brightest of the planets, Venus, may sometimes be seen in the daylight. The planets take the same general path the sun takes across the sky.

It is suggested that the activity be started in good weather, probably in the early fall or spring when the nights are reasonably long and warm. Because moonlight tends to hide the planets as well as the stars, it may help to do the observations before the moon rises or after the moon sets.

Because you will be giving directions, it is important to view the planets yourself before giving the students clues as to where to look. Information on the rising and setting of planets can be found in almanacs. Using almanacs and their planet finders, the students should be able to see which of the constellations to use in guiding their search for a planet.

Movement of Planets in the Constellations

The planets are normally found by referring to their location in the constellations of the zodiacal band. When the students map the movement of the planets, particularly Mars, Venus, and Mercury, they will find that the planets move back and forth. For some period they will move at a fairly constant rate through the constellations and then reverse direction. Later they will resume their original paths. DASH students will continue to study this **retrograde motion** in grades 5 and 6. Here they merely observe and record it.

Planet Finder

The students make planet finders to help find the zodiac constellation each planet will be in or near. Because of the brightness of the planets compared to background stars, the finders give enough of a clue to locate the bright planets. See Student Page 4.2.19 PLANETS for cutouts to make a planet finder. This planet finder is designed to be used looking north into the planetarium or sky.

The students will need to refer to almanacs for data on the rising of planets. The closest approximation can be found by using data for the latitude nearest the equator, usually reported in U.S. almanacs as 20° N latitude.

STUDENT ROLE

Astronomer

MATERIALS

Planetariums from Activity 4.2.17 PLANETARIUM
Stiff paper for sun points
Cardboard backing for Planet Finder
Push pins
Almanacs
Student Pages 4.2.19A PLANETS
4.2.19B PLANET FINDER
4.2.19C THE SUN'S ZODIACAL MOVEMENT
4.2.19D PLANETS AND THE CONSTELLATIONS

PRODUCTS

Learning Calendar record
Planet Finders
Completed Student Pages

PROCEDURES

1. **Begin the activity by telling the students that the class is going to continue the study of the planets. Have them summarize their review of past work on Student Page 4.2.19A THE PLANETS.**

   Review by asking such questions as
   - How is a planet like a star? (Get at the observation that they both appear as specks in the night sky.)
   - How is a planet different from a star? (This may be a question for the Wonder and Discover Book. Some students may already know that **stars** are other suns generating their own light, while **planets** are great balls of rock and gas that do not generate light and can be seen only by reflecting sunlight.)
   - Where do we find planets in the sky? (Get at the idea that all planets including Venus and Mars which they may have studied in grade 3 follow the same general path across the sky as the sun.)
   - What is the next brightest object in the sky after the sun and the moon? (It is Venus.)
   - How many planets does the sun have? (Give the students this question as research homework if they do not know the planets. They should find nine with a search going on for more.)

2. **Have the students make a planet finder using the cutouts on Student Page 4.2.19B PLANET FINDER.**

   Have them
   - Cut out the zodiacal constellation circle, sun clock, and sun and planet pointers.
   - Use Student Page 4.2.19C as a reference and mark the constellation circle with the dates the sun is in each zodiacal constellation.)
   - Pin the constellation circle and the sun and planet pointers in the middle of the 24-hour sun clock so they can turn freely.
   - Reinforce the Planet Finder with a cardboard backing.

3. **Have the students use their planet finder.**

   Ask such questions as
   - What zodiacal constellation will the sun be in on December 25? (Have the students use the date December 25 and place their sun

pointer over the constellation Sagittarius which the sun will have just entered.)

- What constellation will the sun move to next? (Work toward agreement that it will move one constellation to the right, to Capricornus.)

4. **Have the students invent a way to use their finder to predict which of the constellations Saturn was found in on December 25, 1992. Give the following data: Sunrise December 25, 1992, at latitude 20° N was 0633 hours. Saturn rose at latitude 20° N at 0935 hours.**

Ask such questions as

- What did you find? (Record all answers. Saturn was almost in Aquarius.)
- How did you find the constellation? (Explore techniques. Work for such explanations as through the 24 hours of the day and night all 12 of the major constellations of the zodiac rise successively at the sunrise position. That means a new constellation appears every 2 hours. The time between sunrise and Saturn's rising is about 3-1/2 hours—almost 2 constellations after Sagittarius or almost into Aquarius.)
- How can we show this on our planet finder? (Work for placement of the sun pointer in Sagittarius. The sun clock tells the time of day. Sagittarius and the sun pointer are moved together and placed at the hour of Saturn's rising—0935 hours. The students should then put the planet pointer at the rising position of Saturn—0633 hours. They should see that when the planet rises, Aquarius will be about to come up.)

5. **Have the students practice finding the constellations in which other planets were found on December 25, 1992, at 20°N. Sunrise remains at 0633 hours.**

Times of Rising of Planets at 20°N

Venus	Mars	Jupiter
0332 hr	0531 hr	2233 hr

All times use a 24-hour clock.

- Venus rose 3 hours ahead of the sun and was found in Scorpius.
- Mars rose 1 hour ahead of the sun and was still found in Sagittarius.
- Jupiter rose 16 hours after the sun rose and was found in Leo.

6. **Start a Venus watch.**

   Have the students
   - Use almanac data to find where to look for Venus.
   - Determine whether Venus will be visible in the early morning or in the evening.

7. **Discuss the first night-morning observation.**

   Ask such questions as
   - Did anyone find Venus?
   - Can you tell us how you found it?
   - What time was it when you found Venus?
   - What kind of problems did you have? (When possible, allow the students to solve each other's problems.)
   - Did anyone have to solve that problem? How did you do it?
   - Who will record on the Learning Calendar the constellation in which Venus was found?

8. **Add planets one at a time until the students become generally successful in their search. Periodically post a new planet with rising and setting data.**

   Have the students work in groups to find out where they will look. Have them find Mars and Jupiter first, then Saturn, and last, as a challenge, Mercury.

   In discussion ask such questions as
   - Did anyone find our planet?
   - Can you tell us how you found it?
   - What time was it when you found the planet?
   - What kinds of problems did you have? (When possible, allow the students to solve each other's problems.)
   - Did anyone have to solve that problem? How did you do it?

9. **Weekly have the students post on the Learning Calendar the constellation that each of the planets is in and the planet's time of rising.**

10. **At the end of the year have the students use Student Page 4.2.19D PLANETS AND THE CONSTELLATIONS. Duplicate one table for each planet the students observe. Have the students use Learning Calendar data to trace the path of the planets through the constellations. See Figure 4.2.19.**

    Ask such questions as
    - What were the similarities in the paths of the planets? (Work to the idea that they all moved through the constellations.)
    - What were the differences in the paths of the planets? (Expect such answers as some went slower than others. If observed long enough, Mercury, Venus, and Mars seem to move back and forth among the constellations.)

EXTENSIONS

Have the students
- Make a bulletin board of the planets.
- Post articles about the planets.

ZODIACAL LOCATION OF MARS EACH MONTH IN 1991

Months	Constellations of the Zodiac											
	CAP	AQU	PIS	ARI	TAU	GEM	CAN	LEO	VIR	LIB	SCO	SAG
JAN.					■							
FEB.					■							
MAR.					■							
APR.						■						
MAY							■					
JUNE							■					
JULY								■				
AUG.									■			
SEPT.												
OCT.												
NOV.												
DEC.												▨

Figure 4.2.19 Use of the zodiacal location chart showing the constellations in which Mars was found each month during 1991. The blanks from September through November occur because Mars is obscured by the sun.

Name______________________

Date______________________

STUDENT PAGE 4.2.19A THE PLANETS

1. How is a planet like a star?

2. How is a planet different from a star?

3. Where do we find planets in the sky?

4. What is the next brightest object in the sky after the sun and the moon.

5. How may planets does the sun have? What are they?

SP 4.2.19B
PLANET FINDER

Name ______________________

Date ______________________

Cut out and assemble the items below to make a planet finder.

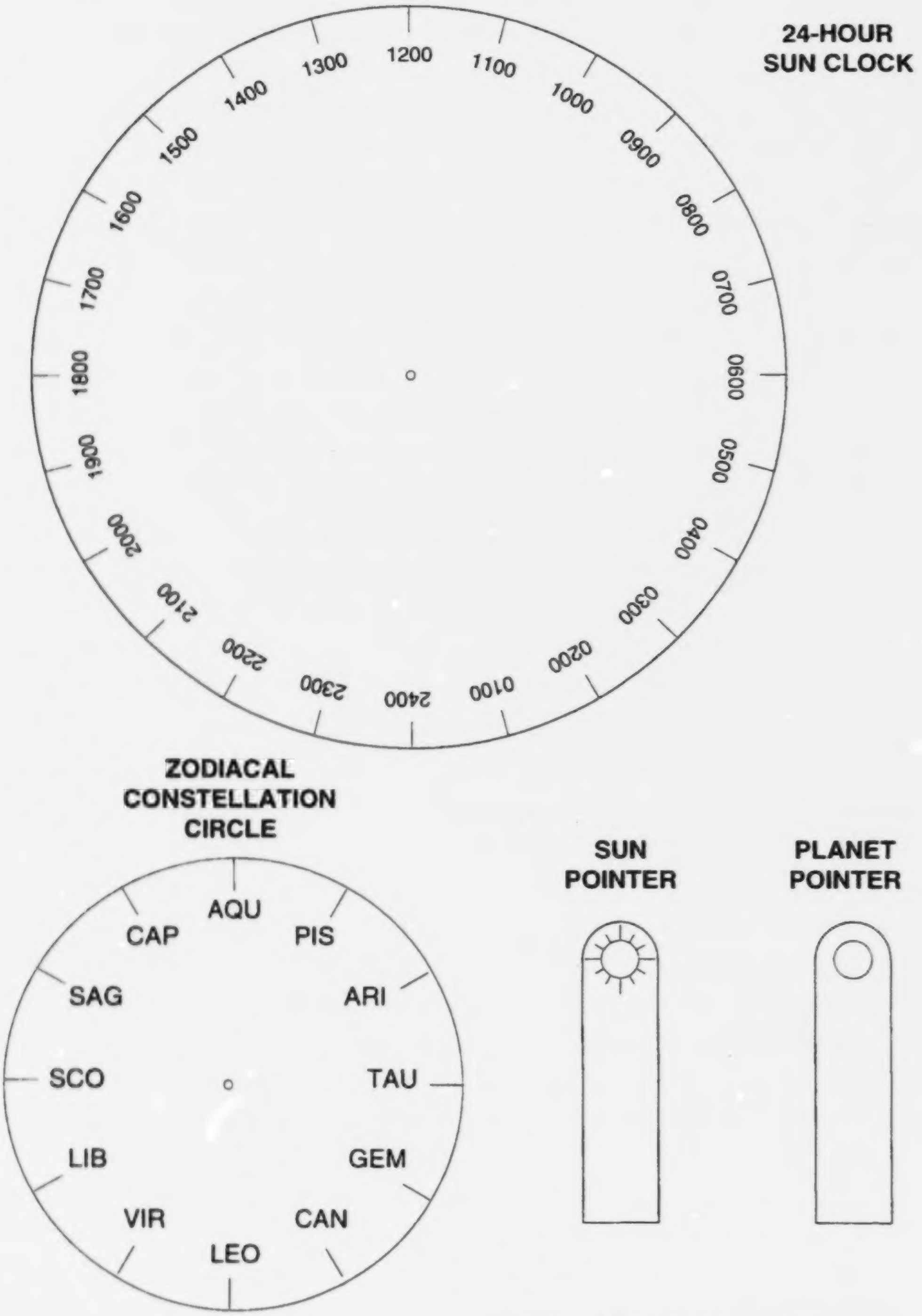

24-HOUR SUN CLOCK
1200
1100
1000
0900
0800
0700
0600
0500
0400
0300
0200
0100
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
ZODIACAL CONSTELLATION CIRCLE
AQU
PIS
ARI
TAU
GEM
CAN
LEO
VIR
LIB
SCO
SAG
CAP
SUN POINTER
PLANET POINTER

Figure SP 4.2.19B Planet finder

DASH

Name________________________

Date________________________

STUDENT PAGE 4.2.19C THE SUN'S ZODIACAL MOVEMENT

CONSTELLATION NAMES IN ZODIACAL ORDER	*DATES SUN IS IN THE ZODIACAL CONSTELLATION
Capricornus, the Goat	January 19–February 15
Aquarius, the Water Bearer	February 16–March 11
Pisces, the Fishes	March 12–April 18
Aries, the Ram	April 19–May 13
Taurus, the Bull	May 14–June 20
Gemini, the Twins	June 21—July 19
Cancer, the Crab	July 20–August 9
Leo, the Lion	August 10–September 15
Virgo, the Virgin	September 16–October 30
Libra, the Balance	October 31–November 22
Scorpius, the Scorpion	November 23–December 17
Sagittarius, the Archer	December 18–January 18

*Adjust for Leap Years

DASH

STUDENT PAGE 4.2.19D
PLANETS AND THE CONSTELLATIONS

Name____________________

Date____________________

Locate the constellation a particular planet is in by checking or shading in the box under the name of the constellation.

ZODIACAL LOCATION OF ____________ EACH MONTH IN 199__

Months	Constellations of the Zodiac											
	CAP	AQU	PIS	ARI	TAU	GEM	CAN	LEO	VIR	LIB	SCO	SAG
JAN.												
FEB.												
MAR.												
APR.												
MAY												
JUNE												
JULY												
AUG.												
SEPT.												
OCT.												
NOV.												
DEC.												

ACTIVITY 4.2.20 WHEN IS IT NOON?

OBJECTIVES

The students
- Identify solar noon as the time of the shortest gnomon shadow.
- Determine that solar noon is usually closer to standard time than daylight saving time.
- Determine that magnetic declination can be found using solar noon.

BACKGROUND

This activity is the second of a series on sun shadows. It should be done after Activity 4.2.16 THE SUN'S SHADOW PATH has been started and should be followed by Activities 4.2.21 MAKING A SUNDIAL and 4.2.22 USING A SUNDIAL.

Time To Start

WHEN IS IT NOON? can be done in either the fall or spring of the year, though fall is preferable. Start several weeks before the shift from or to daylight saving time. Daylight saving ends the last Sunday in October and starts on the first Sunday in April. During late fall and winter all states are on standard time.

Approach

There are four parts to the activity. In the first part, the students review their use of the gnomon and establish that solar noon is the time of shortest shadow. In the second, they find that solar noon normally is closer to standard time noon than daylight saving time noon. In the third, they find that the solar noon shadow is aligned north and south. In the fourth, they find that the magnetic north-south line differs from the solar north-south line in many places.

Solar Noon

Solar noon is the instant when the sun crosses the meridian, the imaginary line directly overhead that goes from pole to pole. It can be found by watching the gnomon. At solar noon the gnomon shadow will point straight north and will be the shortest shadow of the day. The students can get a fair approximation of solar noon by using sunrise and sunset data and then checking the gnomon every five minutes or so for an hour before and after the estimated time.

Local and Standard Time

The students may observe that the clock noon and solar noon are not the same. This is due to two things. First, the world is divided into time zones and the noon time for a time zone is someplace in the middle of the zone. Places to the west of this point will have an early noon, and those to the east will have a late noon. Second, solar noon changes a few seconds each day from standard clock noon. Sometimes solar noon is before, sometimes after standard time noon. Solar noon is tabulated in almanacs under the heading "Sun on Meridian." This tells us how many minutes before or after standard time noon the sun actually crosses the meridian or mid point in the sky.

Magnetic Declination.

The celestial or rotational poles and the magnetic poles of Earth are not at the same place. In most locations the compass needle reading must be corrected to give true north. The number of degrees the compass needle is pulled either west or east of true north is called the **angle of magnetic declination**. This is 20° or more east in the northwestern part of the United States and 15° or more west in the northeastern part. In addition, because of magnetic anomalies in the different regions, there may be local magnetic variations. For example, magnetic iron deposits can cause an anomalous deflection. The Mesabi iron deposit in Minnesota is reported to have been found by a hunter whose compass gave false readings.

The angle of magnetic declination can be found by using the gnomon shadow at solar noon and measuring how many degrees the shadow differs from magnetic north. The difference is the magnetic declination.

Isogonic Lines of Magnetic Declination

Isogonic lines of magnetic declinations indicate places that have the same compass angle. See Figure 4.2.20. The regions between the lines have intermediate angular magnitudes. For approximation, you can use the nearest isogonic line.

STUDENT ROLE

Astronomer

MATERIALS

Gnomon data from Activity 4.2.16 THE SUN'S SHADOW PATH

Student Pages 4.2.15A LENGTH OF DAY GRAPH
4.2.15B LENGTH OF NIGHT GRAPH
4.2.20 WHEN IS IT NOON?

PRODUCTS

Completed Student Pages

PROCEDURES

1. **State that we need to find out what has happened to the gnomon data or the sun's shadow now that we have changed to or from daylight saving time. All gnomon data should be registered in clock time.**

   Ask such questions as
   - What seems to happen to the sun's shadow each day as the clock time gets closer to noon? (Work to agreement that it seems to get shorter.)
   - What seems to happen to the shadow each day in the afternoon? (It seems to get longer.)
   - When would you expect the shortest shadow in the day? (Work toward the idea that it should be seen in the middle of the day, near noon, or about halfway between sunrise and sunset.)
   - How could we test the hypothesis that the shortest shadow is found at midday? (Lead the students to use their gnomons to test the idea that the shortest shadow of the day should be about halfway between sunrise and sunset.)

2. **Have the students test their hypotheses the next few times the sky is clear at noon.**

   Generalize the results by asking such questions as
   - Were your predictions close?
   - Where was the sun at the time of shortest shadow? (Get at the idea that it was at its highest position in the sky.)
   - What is a working definition for solar noon? (Work to a definition that solar noon is the time when the sun is halfway in its path across the sky. We observe it as the time of shortest gnomon shadows.)

3. **Have the students measure the length of the 1200-hour shadow three weeks before and three weeks after the shift from daylight saving to standard time.**

   Ask such questions as

   - How does the 1200-hour shadow look during daylight saving time compared to the standard time 1200-hour shadow? (It almost always gets shorter in the fall when we switch to standard time, and it gets longer when we switch to daylight saving time in the spring.)
   - Is solar noon closer to standard time or daylight saving time noon? (Normally it is closer to the standard time noon.)
   - How can we extend our working definition of solar noon to include standard time? (Work to inclusion of the fact that standard time is closer to solar time than daylight saving time.)

4. **Have the students observe the noon shadow and relate it to their "body compass." Have them orient themselves using the following mnemonic:**

   Right rising, EAST.
   Left leaving, WEST.
   Nose, NORTH.
   Seat, SOUTH.

   Ask such questions as

   - Where is the morning sun? (Work to agreement that it is on our east side.)
   - Where is the morning shadow? (Work to agreement that it is on our west side.)
   - Where is the noon sun? (Work to agreement that it is overhead and somewhat south of us.)
   - Where is the noon shadow? (Work to agreement that it is pointing north.)

5. **Have the students check the north-south orientation of the solar noon shadow with a magnetic compass.**

   Ask such questions as

   - Does the gnomon shadow at noon point in the same direction as the magnetic compass? (Where there is a significant magnetic declination [3°–5° or more], the students will see that the two north-determining systems do not correspond. If there is no

significant difference, the following technicality need not be raised.)
- Has anyone heard of magnetic declination? What does it mean?

6. **Explain magnetic declination.**

Touch on such points as
- Map makers and scientists use two Earth poles. One is the **celestial pole,** the same point the solar noon shadow points to. The other is the point the needle of a magnetic compass points to. This is called the **magnetic pole.**
- The north magnetic pole moves over time and now is in northern Canada near Prince of Wales Island. It was recently surveyed at 76° N latitude and 101° W longitude. It had moved about 6° north and 5° west over a seventy-year period.
- We can find true north by rotating the dial of a magnetic compass a certain number of degrees from the magnetic north reading. This difference between the true celestial north and magnetic north is called the **angle of magnetic declination**.
- We find magnetic declination shown on certain maps, particularly geodetic survey maps.

7. **Have the students invent a way to use their solar noon, the true-north gnomon shadow, and a magnetic compass to find the magnetic declination of their school.**

Have them
- Compare their declination determinations and arrive at an average.
- Check their declination with a local geodetic survey map or use the approximate data from Figure 4.2.20.

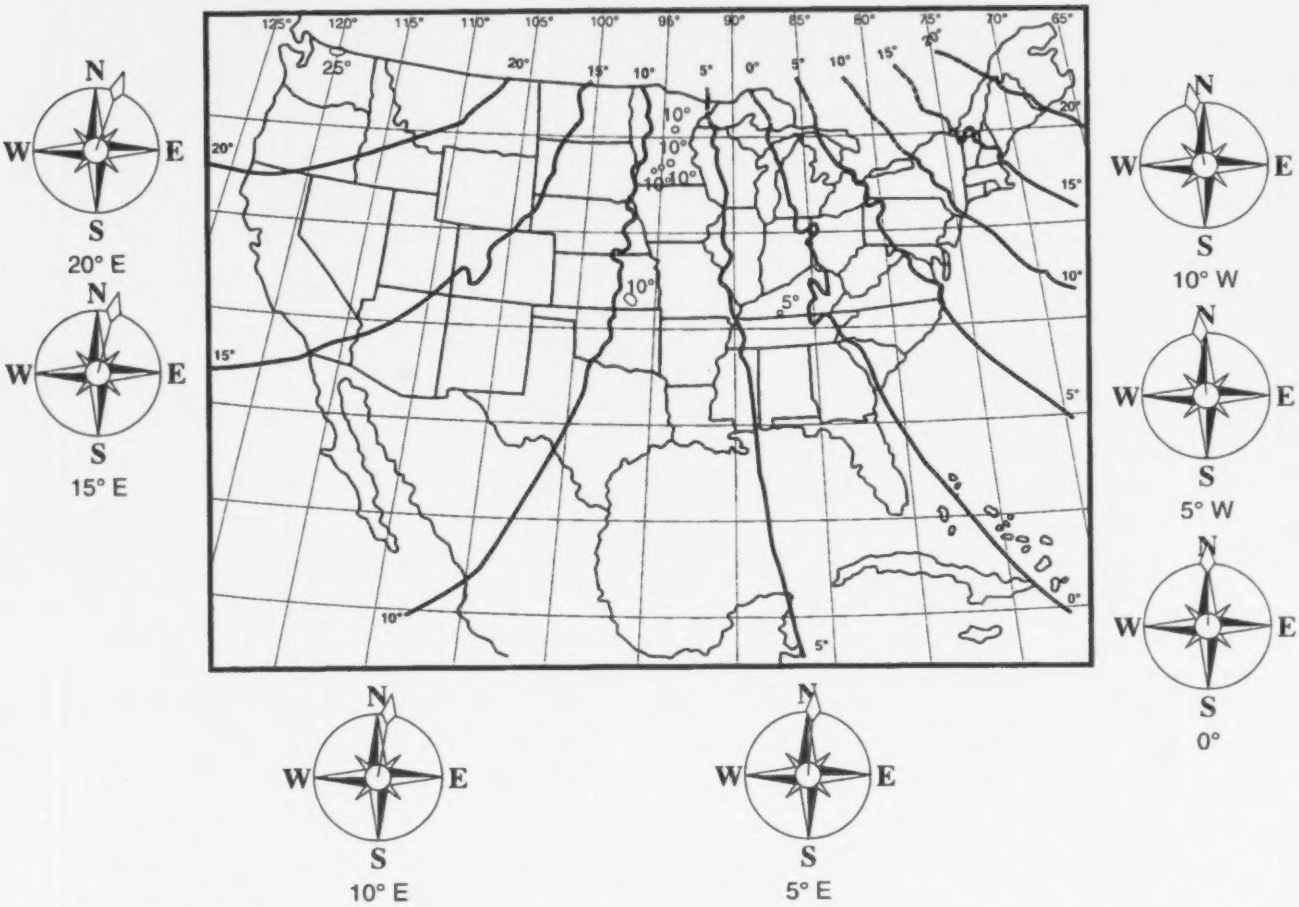
8. **Summarize the activity to answer the question When is it noon?**

Ask such questions as
- When is it clock noon? (Work to agreement that clock time is at 12:00 a.m. or 1200 hours.)
- When is it solar noon? (Work to agreement that it is at the time of the sun's mid transit across the sky, the time of shortest gnomon shadow when the shadow points north and south.)
- How can we use a magnetic compass to tell when it is noon? (Work to agreement that we could tell when it is noon by

correcting for magnetic declination and determining true north and then finding when a gnomon shadow is along this true north-south line.)

EXTENSIONS

Have the students report on
- Why we have daylight saving time.
- Why we have daylight saving time in some states and not in others.
- How magnetic north was found.


125°
120°
115°
110°
105°
100°
95°
90°
85°
80°
75°
70°
65°
25°
20°
15°
10°
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10° E
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5° E
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W
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S
10° W
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W
E
S
5° W
N
W
E
S
0°

Figure 4.2.20 Isogonic lines of magnetic declination

Name________________________

Date________________________

STUDENT PAGE 4.2.20 WHEN IS IT NOON?

1. When is the shadow of the sun the shortest?

2. Record your working definition for solar noon.

3. What is the magnetic declination at your school? Describe how you found it?

ACTIVITY 4.2.21 MAKING A SUNDIAL

OBJECTIVES

The students
- Discuss the limitations of using a nail gnomon as a sundial.
- Discuss the need for an hour of standard length.
- Measure the altitude angle of the North Star or the school's latitude.
- Make an Arabic sundial.

BACKGROUND

This activity follows 4.2.16 THE SUN'S SHADOW PATH, 4.2.17 PLANETARIUM, 4.2.18 USING THE PLANETARIUM, and 4.2.20 WHEN IS IT NOON? and precedes 4.2.22 USING A SUNDIAL.

In MAKING A SUNDIAL the class discusses problems in using the sun as a clock. The students are led into a discussion of the need for constant time periods and whether the angles of the gnomon shadows can provide them.

The Arabic sundial is then introduced. To make such a sundial the students need to find the altitude angle of the North Star (Polaris). To find this they estimate the number of degrees the North Star appears above the horizon.

Finding the North Star

The students use their personal planetarium to find the North Star by orienting the planetarium to the current month. They should keep in mind that the North Star is the last star in the handle of the Little Dipper and the two pointer stars on the front edge of the Big Dipper are aligned with it.

Altitude Angle of the North Star

The students use their fists to determine the altitude angle by aligning the bottom of the first fist with the horizon and piling fists and fingers on top until they are in line with the North Star. See Figure 4.2.21(1). They should allow 10° for a fist; 2°, for a finger. The latitude of your school will be the same as the altitude angle of the North Star. The latitude can be obtained from state road maps. Where the North Star cannot be seen, use the latitude from a road map.

Light from a star can be thought of as a shaft of light. The altitude angle is the angle that shaft makes with Earth's level surface. One simple device to find the altitude angle can be made using a piece of cardboard, a luminous string, and a plumb bob. See Figure 4.2.21(2). The students' observations will vary by several degrees plus or minus the true latitude. Averaging the student data will give an altitude angle within an acceptable range.

Constructing a Sundial

The students can construct a sundial by making a cardboard triangle with one angle having the same number of degrees as the altitude angle of the North Star. See Figure 4.2.21(3). When they attach the triangle to heavy cardboard or a board, the triangle becomes a sundial.

STUDENT ROLE

Astronomer

MATERIALS

String
Luminous paint
Push pins
Protractor
Cardboard
Masking tape
Glue
Shadow *V* s from Activity 4.2.16 THE SUN'S SHADOW PATH
Student Page 4.2.21 MAKING A SUNDIAL

PRODUCTS

Sundials
Completed Student Pages

PROCEDURES

1. **Review the observation of the sun's shadow to date.**

Ask such questions as
- What happens to the length of the sun's shadow during the day? (Probe for the idea that it gets shorter up to noon, then gets longer again.)
- When is the shadow the shortest? (Help the students recall that in Activity 4.2.21 WHEN IS IT NOON? they found that the shortest shadow was at noon.)
- What happens to the shape of shadow *Vs* from September to December? (Review Activity 4.2.16 THE SUN'S SHADOW PATH. Make sure the students are aware that the *Vs* went from a wide angle in the beginning to a narrower angle around December 25.)
- How might we use the sun to tell time before and after noon? Can we make a sundial so that the 0800-hour shadow always falls on the same line? So that the shadows at all the hours of the day fall on the same lines every day?

2. **Explain that from ancient times it has been understood that noon splits the day in half. It seemed reasonable that the shadows of the first gnomon reading in the morning and the last in the evening should be used to start and end the day.**

   Start a discussion by asking such questions as
   - What would this do to the length of the working day in the summer?
   - What would this do to the length of the working day in the winter?
   - What advantage might there be to a longer working day in the summer and a shorter working day in the winter? (Get at the idea that crops in many parts of the world have been grown only in summer.)

3. **Discuss the disadvantages of such a system for people who did not work all day long in the fields and needed to arrange meetings and do several different things throughout the day.**

   Ask such questions as
   - What would be some of the disadvantages of a clock that shows only sunrise, sunset, and noon?
   - Compare the length of time between sunrise and sunset in the winter and in the summer. What is the difference? (Get at the idea that the time interval is greater in summer than in winter.)

- If we were to divide the interval from sunrise to sunset in winter and summer into 12 periods and call these time periods "hours," how would the length of summer and winter hours compare? (Get at the idea that the summer hours would be longer than the winter hours.)
- What disadvantages might there be in having hours of different length? (Work to such ideas as we would have to change our clocks every day, in the summer when it is hot we would have to work long hours, and timetables for buses, trains, and planes would have to be changed every day.)
- What would be the advantages of having constant time periods?

4. **Explain that people invented all kinds of clocks. Some used flowing water; others used sand, burning wax, or oil. They also modified and improved on the gnomon as a way of helping them tell time.**

   Ask such questions as
   - How could sand be used to tell time? Can you draw a picture of a device using sand? Why is the hour always the same? (Help the students get at the idea that given the same amount of sand each hour, dry sand will flow at the same rate through a hole.)
   - How could a water clock be made?
   - What would be some disadvantages to a water clock? A sand clock?

5. **Explain that Arab astronomers observed that if one made a gnomon that was slanted to line up with the North Star, the sun's shadow would always point to the same place on a dial for each hour of the day. The interval of time on this clock was constant. See Figure 4.2.21(3).**

   Ask such questions as
   - How could we get a gnomon to point toward the North Star?
   - How do we tell where north is? (Work for several different answers such as looking at the shadow of the gnomon at local noon, using a compass, and taking into account the magnetic declination.)
   - How do we find the North Star? (Review Activity 4.2.18 USING THE PLANETARIUM.)
   - How can we find the altitude angle of the North Star? (Draw an altitude angle to help the students visualize the problem.)

6. **Have the students invent and make a device to measure the altitude angle of the North Star.**

   Have the students
   - Construct their own devices for measuring altitude angles. (See Figure 4.2.21(2) for an example.)
   - Practice using their devices.
   - Check the angle measured using the fist-finger method introduced in Activity 4.2.5 HEIGHT OF CLOUDS. (See Figure 4.2.21(1).)
   - At home or on a night field trip measure the angle between the North Star and the horizon. (Data should be shared to establish an average angle. Have the students decide whether any data are so far from the norm that they need to be thrown out.)

7. **Have the students make a sundial.**

   Have them
   - Make an altitude triangle that lines up with the North Star and describe what they did on Student Page 4.2.21 MAKING A SUNDIAL.
   - Invent and make an unmarked sundial using the triangle. (The students will systematically mark the sundial in Activity 4.2.22 USING A SUNDIAL.)
   - Explore telling time with their sundial.

EXTENSION

- Have the students make a water clock.

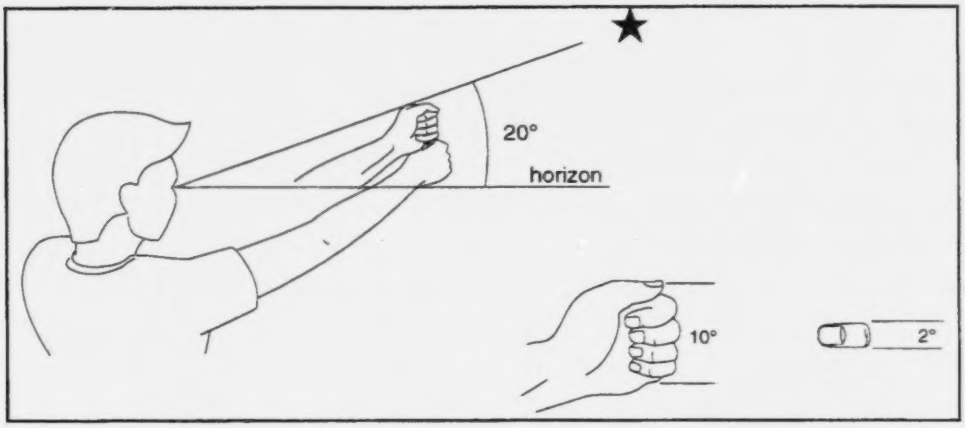
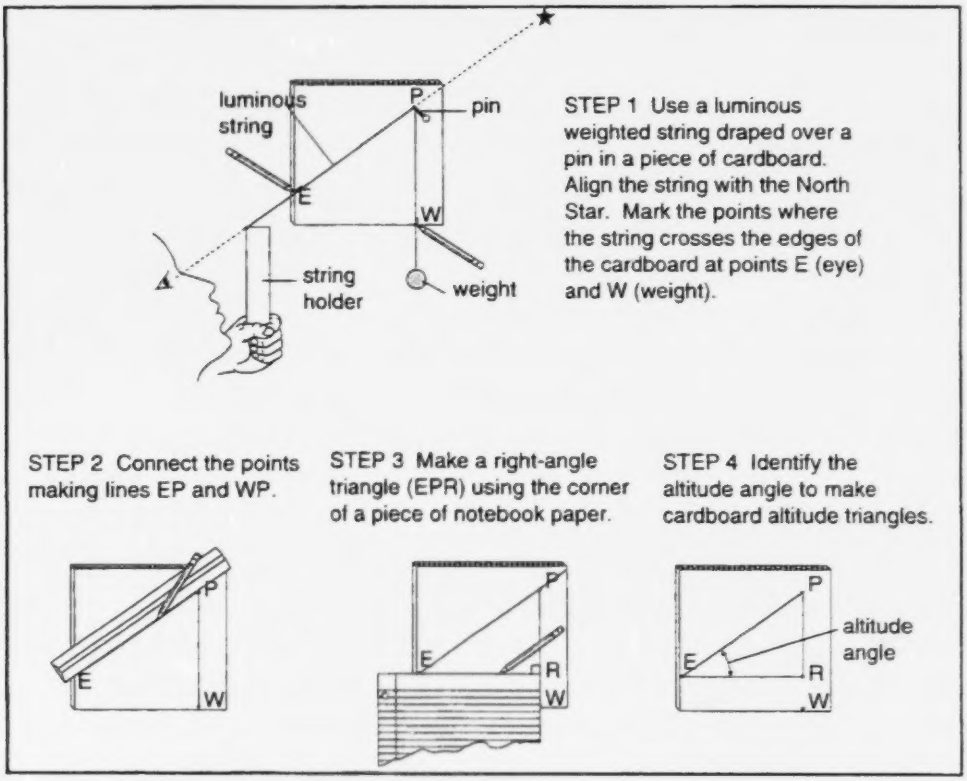

20°
horizon
10°
2°

Figure 4.2.21(1) Fist-finger method of finding the altitude angle of the North Star


luminous string
P
pin
E
W
string holder
weight
P
E
W
P
E
R
W
P
E
R
W
altitude angle

STEP 1 Use a luminous weighted string draped over a pin in a piece of cardboard. Align the string with the North Star. Mark the points where the string crosses the edges of the cardboard at points E (eye) and W (weight).

STEP 2 Connect the points making lines EP and WP.

STEP 3 Make a right-angle triangle (EPR) using the corner of a piece of notebook paper.

STEP 4 Identify the altitude angle to make cardboard altitude triangles.

Figure 4.2.21(2) Luminous string technique for finding the altitude angle of the North Star

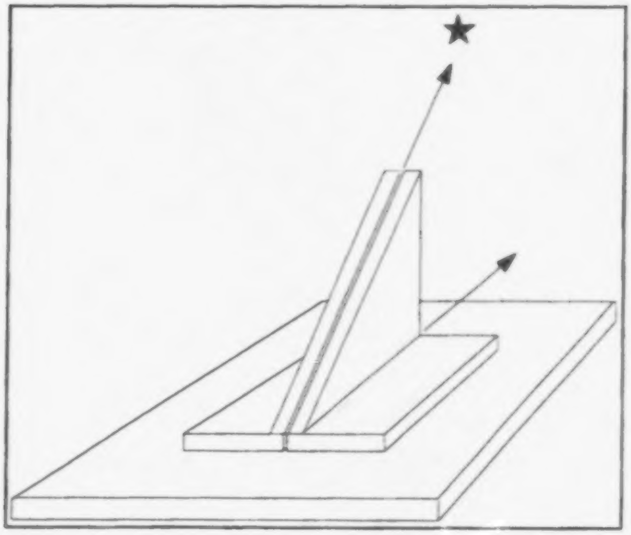


Figure 4.2.21(3) Cardboard altitude triangles attached to a base to make a sundial

DASH

Name________________________

Date________________________

STUDENT PAGE 4.2.21 MAKING A SUNDIAL

1. Explain why the shadow from a gnomon makes a poor sundial.

2. Describe how you found the altitude angle of the North Star.

3. Describe how you made your sundial.

ACTIVITY 4.2.22 USING A SUNDIAL

OBJECTIVES

The students
- Calibrate their sundials.
- Use time zone data.

BACKGROUND

This activity follows 4.2.16 THE SUN'S SHADOW PATH, 4.2.20 WHEN IS IT NOON?, and 4.2.21 MAKING A SUNDIAL.

In USING A SUNDIAL, the students observe and mark the sun's shadow each hour. They can do this in one day or spread their data taking over the course of a week or more. They can observe and mark hours beyond the school day at home.

Testing the correctness of the sundial markings can be done at any later time. The sundial is correctly marked and aligned if the shadow always falls very near the same line at the same hour. The students mark their sundials to read standard time for their location in their own time zone. Using a sundial as a class clock will help them appreciate our modern mechanical clocks.

Local Time and Standard Time

The students will probably observe that clock or standard time noon and local solar noon on their gnomon do not exactly coincide. As observed earlier in Activity 4.2.20, this is due to two things. First, the world is divided into time zones and the noon time for each time zone is someplace in the middle of it. Second, solar noon changes a few seconds each day. Sometimes solar noon is earlier and sometimes later than standard clock noon. Solar noon corrections can be found in almanacs under the heading "Sun on Meridian." These corrections tell us how many minutes before or after standard clock noon the sun actually crosses the meridian or mid point in the sky.

STUDENT ROLE

Astronomer

MATERIALS

Sundial
Watch or clock
Student Pages 4.2.22A USING A SUNDIAL
4.2.22B TIME ZONES

PRODUCTS

Calibrated sundials
Completed Student Pages

PROCEDURES

1. **Review previous work with the gnomon and local solar time and making a sundial.**

   Ask such questions as
   - With proper north-south alignment, what would you expect the shape of the sundial shadow at local solar noon to be? (It should be a straight line.)
   - In what direction would you expect the noon shadow made by the sundial to point? (Work around to the idea that the tip end of the triangle is like a point and will point to true north.)
   - How do we know the direction of the noon shadow? (Have the students recall that the orientation of their gnomon at noon was on a north-south line.)
   - How will the length of the noon shadow compare with other shadows throughout the day? (Help the students recall from Activity 4.2.20 WHEN IS IT NOON? that it will be the shortest of the day.)

2. **Have the students align their sundials along the celestial north-south line. Have them invent their own technique of alignment and describe it on Student Page 4.2.22A USING A SUNDIAL.**

   The technique can take several forms:
   - The local solar noon shadow line can be used.
   - A magnetic compass can be used with declination correction.
   - The North Star alignment line can be used.

3. **Switch from local solar time to clock hours. At each clock hour have the students mark the shadow line on their sundials and label it.**

   After the first hour is marked, have the students
   - Predict where the shadow line will fall at the next hour on the school clock.
   - Predict how long this shadow line will be.

4. **Have the students compare their sundial and gnomon data.**

   Ask such questions as
   - How does the noon of our marked sundial correspond with the local solar noon or the shortest shadow on the gnomon? (They should be fairly close—within an hour.)
   - How does the noon of our marked sundial correspond with the clock time? (They should be about the same.)
   - Would students who are 200 or more miles east or west of us have the same local solar noon time as we have? Would their gnomon show noon when ours shows noon? (This is a researchable question. It is an ideal time to initiate a phone call to another DASH school that is east or west and check to see where the gnomon shadow is when yours shows noon. In the continental United States, depending on the latitude, there will be a 6–8 minute difference for each 100 miles of distance east or west. It is best to contact a school several hundred miles east or west so that the time difference is great enough to be apparent on small sundials.)
   - Why would this difference exist? (Use a map and lead the students to see that the sun appears to move from east to west. East of you, the sun would be overhead before it would be overhead where you are located. Also have them note that west of you, the process would be the opposite. That location would get the noon sun later.)
   - When it is noon on our standard time sundial, what time do you think it is on the clock at another place in our time zone that is quite some distance east or west? (Time can be checked when phoning another DASH school or by phoning the time operator for a distant city. Unless the call has gone across a time zone, all clocks in the zone will be about the same. Because the students' sundials were standardized to clock time, they should all read about the same.)

5. **Introduce standard time zones using Student Page 4.2.22B TIME ZONES.**

Ask such questions as
- How many time zones are there in Hawai'i, Alaska, and other U.S. states?
- Which time zone are we in?

- Which way does the sun appear to move across these time zones? (Have the students trace the sun's movement in the sky using the mnemonic

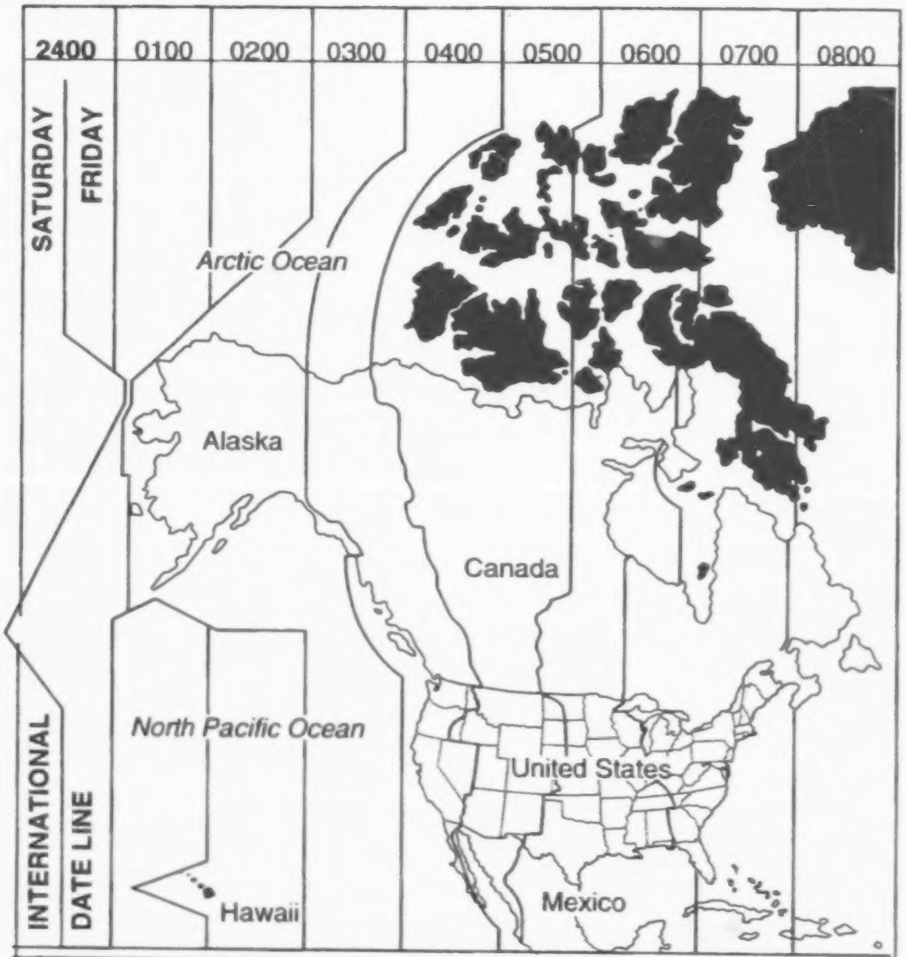
  Right rising EAST.
  Left leaving WEST.
  Nose NORTH.
  Seat SOUTH.

  The sun moves from east to west, right to left when facing north.)
- If it is 12:00 noon in our time zone, what time is it in the zone to the west of us? (Lead the students to see that it would be an hour earlier, 11:00 a.m. or 1100 hours.
- What time is it in the zone to the east of us? (Lead them to see that it would be an hour later (1:00 p.m. or 1300 hours) because the sun has already passed overhead there. This is a good time to review the meaning of "a.m." and "p.m.")
- Would you want to make a "how are you" phone call to a friend in Hawai'i when it is 6:00 a.m. your time? Why? (Get at the time difference. It would be 5:00 a.m. in Hawai'i when it is 6:00 a.m. in Alaska, 4:00 a.m. in Hawai'i when it is 6:00 a.m. on the West Coast, and so forth.)
- What happens to the time in our time zone as the time changes at the international date line?
- Have the students use Student Page 4.2.22B TIME ZONES.

EXTENSIONS

- When the students communicate with another school to get time information, have them ask what the altitude angle of the sundial is. Have them locate the school on a globe and relate altitude and latitude.

- Challenge the students to invent a sundial so that it can be adjusted and read to give the proper local or solar time wherever it is used. (Help them think through the idea that such a sundial would have an angle that is equal to the local latitude and a noon at the shortest shadow. A simple sundial can be made using a flexible wire and a protractor.)
- Challenge the students to invent a sundial that can be read with greater precision to within 2-4 minutes. (Such a clock would need to have a large shadow post.


2400
0100
0200
0300
0400
0500
0600
0700
0800
SATURDAY
FRIDAY
Arctic Ocean
Alaska
Canada
North Pacific Ocean
United States
Hawaii
Mexico
INTERNATIONAL
DATE LINE

0100	0200	0300	0400	0500	0600	0700	**0800**	0900
0200	0300	0400	0500	**0600**	0700	0800	0900	1000
0300	0400	0500	0600	0700	0800	0900	1000	**1100**
0400	0500	**0600**	0700	0800	0900	1000	1100	1200
0500	0600	0700	0800	0900	**1000**	**1100**	1200	1300
0600	**0700**	0800	0900	1000	1100	1200	1300	1400
0700	0800	0900	1000	1100	**1200**	1300	1400	1500
0800	0900	1000	1100	1200	1300	1400	**1500**	1600
0900	1000	1100	**1200**	1300	1400	1500	1600	1700
1000	1100	1200	1300	1400	1500	1600	1700	**1800**
1100	1200	**1300**	1400	**1500**	1600	1700	1800	1900

Figure 4.2.22 Completed table of time zones from Student Page 4.2.22B

BEST COPY AVAILABLE

Name______________________

Date______________________

DASH

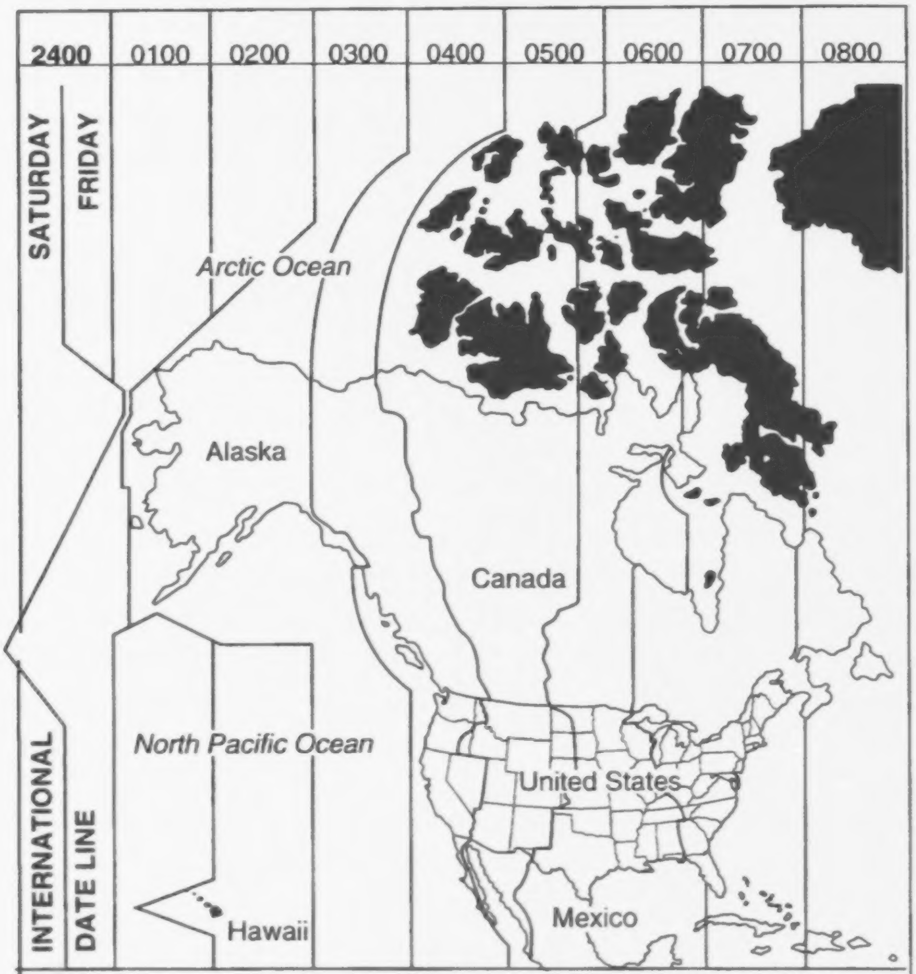
STUDENT PAGE 4.2.22A USING A SUNDIAL

1. Describe how you aligned your sundial so that the post was on a north-south line.

2. Describe how you marked your sundial to read in hours.

DASH	**SP 4.2.22B TIME ZONES**	**Name** ____________________ **Date** ____________________

Fill in the shaded blocks with the correct time for the standard time zone.


2400
0100
0200
0300
0400
0500
0600
0700
0800
SATURDAY
FRIDAY
Arctic Ocean
Alaska
Canada
North Pacific Ocean
United States
Mexico
Hawaii
INTERNATIONAL
DATE LINE

0100	0200	0300	0400				▨	
0200		0400		▨				
0300			0600		0800			▨
0400		▨						
0500					▨	▨		
0600	▨							
0700					▨			
0800							▨	
0900			▨					
1000								▨
1100		▨		▨				

Figure SP 4.2.22B Time zones

ACTIVITY 4.2.23 SEASONS AND THE SUN

OBJECTIVES

The students
- Organize Learning Calendar data for analysis.
- Relate calendar events to the seasons.
- Discover great variability in weather and other seasonal events over time.

BACKGROUND

Each year since kindergarten, DASH students have collected information on weather, temperature, and other seasonal data, analyzing the data at the end of each year. SEASONS AND THE SUN is a continuance of this experience to establish the generality and variability in the seasonal events of the year by condensing them into a large graph.

Organization

The activity should be undertaken near the last of the school year. The Learning Calendar can be separated into one-month segments and given out to student groups for analysis. The data can then be transferred to the Student pages SP 4.2.23-1 through SP 4.2.23-12. See Figure 4.2.23. After the students have completed the activity, the Learning Calendar segments can be taped back together.

Wherever possible, the students should be made responsible for holding the analysis discussion. Seasonal data from previous years should be compared if they are available.

The time of the solstices and equinoxes should be checked with the almanac in leap years. Additional information such as times of plowing, planting, the budding of trees, and the first appearance of insects can be posted on pages SP 4.2.23-6 and SP 4.2.23-12.

STUDENT ROLES

Meteorologist
Ecologist

MATERIALS

Class Learning Calendar
Student Pages 4.2.23 SEASONAL DATA

PRODUCTS

Seasonal data

PROCEDURES

1. **Begin the activity by telling the class that we need to analyze the data we have collected on the seasons.**

   - Cut the Learning Calendar into one-month segments.
   - Have the students work in groups of two or more on each monthly segment to summarize the calendar data on Student Page 4.2.23 SEASONAL DATA.
   - Have the students select the kind of additional information to report on pages SP 4.2.23-6 and SP 4.2.23-12. They may wish to include such things as the times of first plowing, first harvesting, and appearance of the first buds.

2. **Have the students form the Student Page data sheets into a continuous graph. See Figure 4.2.23.**

   Have them
   - Cut or fold the sheets so they give a continuous sequence of days.
   - Blank data sheets can be added for any months for which there are no data. Be sure the actual number of days in the month are accounted for.

3. **Have the students find seasonal boundaries.**

   Ask such questions as
   - When was the first day of winter? (At the **winter solstice**, the shortest day of the year—on or near December 22.)
   - When was the first day of spring? (At the **vernal equinox**, a time of equal day and night—on or near March 21.)
   - When was the first day of fall? (At the **fall equinox**, a time of equal day and night—on or near September 23.)
   - When should the first day of summer be? (At the **summer solstice**, the longest day of the year—on or near June 22.)

4. **Have the students determine the conditions that make each season distinctive. Whenever possible, turn the development of discussion over to the students.**

   Be sure the students ask such questions as
   - What are the special characteristics of each season?
   - When does Earth get the least amount of light?
   - When is it coldest? When is it hottest?
   - What happens to animal life in each season?
   - What happens to plants in each season?
   - What is the weather like in each season?
   - What do farmers do in each season?
   - What special thing do road crews do each season?
   - What special things do schools do each season?

5. **If possible, have the students compare data from previous years. Again help them lead the discussion.**

   Be sure they include such questions as
   - In what ways were other years similar to the past year? In what ways were they different?
   - What can we predict about years to come?

6. **Discuss the patterns of the moon.**

   Ask such questions as
   - How long is a moon cycle? (Between 29 and 30 days.)
   - Does the full moon fall on the same day each year?
   - Will the moon cycle ever repeat itself so that it coincides with the same days of the year as this year? (The students will find that there is a repetition about once every 18 years.)

EXTENSION

- Have the students write a report of their findings for later classes.

(1) SP 4.2.23—1	**(7)** SP 4.2.23—7
(2) SP 4.2.23—2	**(8)** SP 4.2.23—8
(3) SP 4.2.23—3	**(9)** SP 4.2.23—9
(4) SP 4.2.23—4	**(10)** SP 4.2.23—10
(5) SP 4.2.23—5	**(11)** SP 4.2.23—11
(6) SP 4.2.23—6	**(12)** SP 4.2.23—12

Figure 4.2.23 Suggested arrangement of Student Page 4.2.23 to make a continuous graph of seasonal data

DASH

SP 4.2.23 SEASONAL DATA

TEAM:

			1	2	3	4	5	6	7	8	9	10	11
DAYLIGHT (Hr) LINE GRAPH	Midnight	2400											
		2100											
		1800											
		1500											
		1200											
		0900											
		0600											
		0300											
	Midnight	2400											
CLOUD COVER (%) BAR GRAPH		100											
		50											
		0											
DAILY RAINFALL (cm or in) BAR GRAPH		30											
		25											
		20											
		15											
		10											
		5											
		0											

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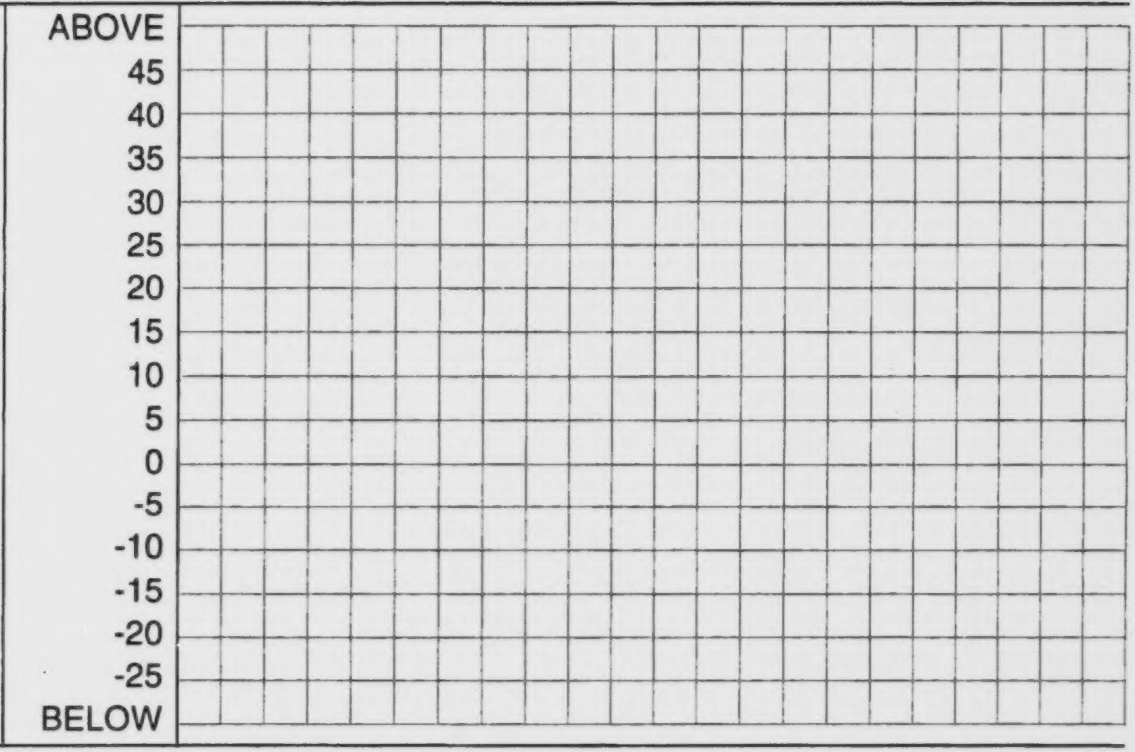
TOTAL RAINFALL FOR YEAR (cm or in) LINE GRAPH	ABOVE 100 90 80 70 60 50 40 30 20 10 0
DAILY SNOWFALL (cm or in) BAR GRAPH	ABOVE 100 90 80 70 60 50 40 30 20 10 0

TEAM:

(3) SP 4.2.23-3

		1	2	3	4	5	6	7	8	9	10	11
TOTAL SNOWFALL FOR YEAR (cm or in) LINE GRAPH	ABOVE											
	750											
	700											
	650											
	600											
	550											
	500											
	450											
	400											
	350											
	300											
	250											
	200											
	150											
	100											
	50											
	0											
SNOW-COVERED GROUND (%) BAR GRAPH	100											
	50											
	0											
STORMY HOURS LINE GRAPH	24											
	18											
	12											
	6											
	0											

TEMPERATURE
(°C)
LINE GRAPH



TEAM:

(5) SP 4.2.23-5

	1	2	3	4	5	6	7	8	9	10	11
SCHOOL VACATION DAYS (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
NEW MOON (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
FIRST QUARTER MOON (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
FULL MOON (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
SECOND QUARTER MOON (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
SOLAR ECLIPSES (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
LUNAR ECLIPSES (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
HIGHEST TIDE (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
LOWEST TIDE (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
OBSERVATIONS											

The DASH Project, University of Hawaii, CRDG

4.4.96

(7) SP 4.2.23-7

Name ________________________________

Date ________________________________

MONTH: YEAR:

DAYS OF THE MONTH

12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

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MONTH: YEAR: **(9)** SP 4.2.23–9

DAYS OF THE MONTH

12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31	

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MONTH: YEAR: **(11)** SP 4.2.23–11

DAYS OF THE MONTH

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
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ACTIVITY 4.2.24 MOON PHASES AND THE SUN

OBJECTIVES

The students
- Observe and correlate times of moonrise and moonset with times of sunrise and sunset.
- Use a moon-phase clock to get the orientation of the moon and sun in the sky.
- Use a body model to simulate the relationship between moonrise and the sun's location during different moon phases.
- Observe the relationship of the bright side of the moon and location of the rising and setting sun.
- Explain moon phases.

BACKGROUND

In this activity the students develop several models of how moon phases are produced. They use moonrise and moonset data collected from the Learning Calendar and Activity 4.2.15 LENGTH OF DAY AND NIGHT.

The students begin the activity by graphing the moonrise data directly on their graph from Activity 4.2.15. They then develop three models for explaining moon phases using the graph as a base. The first model involves Moon-Phase Clocks that the students make. The second uses the head and hands to represent the relative positions of Earth and the moon and sun. The third uses balls and a light beam from a slide projector, flashlight, or overhead projector.

Sunrise and Moonrise Data

To find the relationship of the sun and moon during the major moon phases, the students use Student Page 4.2.15A LENGTH OF DAY. They superimpose the moonrise times and dates on the graph for the four positions—new, first-quarter, full, and third-quarter moons. See Figure 4.2.24(1). From this composite graph they can determine how many hours after the sun rises that the moon rises during each major phase. These data are used in verifying the three models of moon phases described below. Moon and sunrise data are given in many newspapers. If newspaper data are not available, use a current almanac. The students should be able to grapple with the anomaly of daylight saving difference after completing Activity 4.2.22 USING A SUNDIAL.

A Moon-Phase Clock

A Moon-Phase Clock can be made by using the cutouts from Student Page 4.2.24A for moon phase and time rings and sun and moon hands. The clock parts should be fastened together at the center of the time rings. Initially the sun hand should be set on sunrise time.

To operate the clock, start with the full moon. Set the sun hand on sunrise time. Mark this time with a pencil. Next move the sun to the moonrise time and place the full moon on the phase ring at the rising position just marked. Place the moon pointer over the full moon on the phase ring. Throughout that day the moon and sun will follow each other with this 12-hour time separation. Have the students follow the same procedure for each of the four primary moon phases.

Be sure the students recall that in using the sun as a clock, 0600 hours is east, 1200 hours is directly overhead, 1800 hours is on the western horizon, and 2400 is at their feet. Each day the moon rises later and later until the sun catches up with the moon at the new moon.

Hands-and-Head Model of Moon Phases

Figure 4.2.24(2) shows a body model of moon phases using the motion of the hands to simulate the movement of the moon and sun at the major phases. The students should face north with the sun and moon rising on their right. The head is Earth. The right hand carries the sun, and the left hand, the moon.

The following order starts with the new moon. Because all observations are at sunrise, the sun should remain at the east sunrise position of 0600 for each demonstration.

- **New moon**—Both hands are together with the moon in front of the sun.
- **First quarter moon**—The moon in the left hand is at the 2400-hour position, pointing to the feet.
- **Full moon**—The moon in the left hand is at the 1800-hour position opposite the sun.
- **Third quarter moon**—The moon in the left hand is at the 1200-hour position directly overhead.

All positions should be checked with the Moon-Phase Clock.

Ball Model

Figure 4.2.24(3) shows a setup to model moon phases using balls and a slide projector. The students should explore and come up with their own demonstrations.

STUDENT ROLE

Astronomer

MATERIALS

Scissors
Brads
Cardboard to back up cutouts
Black marking pens
Slide projector, flashlight, or overhead projector
Basketball
Student Pages 4.2.15A LENGTH OF DAY
4.2.24A PARTS FOR A MOON-PHASE CLOCK.
4.2.24B MOON PHASES AND THE SUN

PRODUCTS

Moon-Phase Clocks
Completed Student Pages

PROCEDURES

1. **Explain that we need models that show how the moon changes its phases.**

   Ask such questions as
   - Does anyone have a hypothesis as to why the moon goes through phases? (Entertain all ideas and list the hypotheses.)
   - Where were the sun and the moon in relation to each other when we had a full moon? (Record all answers.)
   - How can we use the data from Activity 4.2.15 LENGTH OF DAY AND NIGHT and the Learning Calendar moonrise data to check our answer about the sun and moon's positions at full moon? (Find out the day of the full moon and see what time the sun and moon rose and set. Work toward agreement that the moon rose about the same time the sun set and the moon set as the sun rose.)
   - Does this always seem to occur? (Review the Learning Calendar for other data and verify this.)
   - Where were the sun and the moon in relation to each other when we had a new moon? (Record all answers.)

2. **Have the students use the graph of sunrises and sunsets from Activity 4.2.15 LENGTH OF DAY AND NIGHT and superimpose symbols on the moonrise time for the four primary moon phases—the new, first quarter, full, and third quarter moons. See Figure 4.2.24(1).**

   Ask such questions as
   - About how many hours' difference was there between the times of moonrise and sunrise at the new moon. (Work toward agreement that the risings were about the same.)
   - Where were the moon and the sun throughout the day of the new moon? (Work toward agreement that they must have stayed together because we could not see the moon.)
   - About how many hours' difference was there between the times of moonrise and sunrise at the first quarter moon? (Work toward agreement that the risings were about six hours apart with the moon coming up later.)
   - Where were the moon and the sun during the day of the first quarter moon? (Get agreement that they must have stayed about 6 hours apart)
   - About how many hours' difference was there between moonrise and sunrise at the full moon? (Get agreement that they were about 12 hours apart)
   - About how many hours were there between moonrise and sunrise at the last quarter moon. (Get agreement that the risings were back to being 6 hours apart.)

3. **Have the students make a Moon-Phase Clock showing the relative position of the moon and the sun throughout the day and night. Have them use the cutouts on Student Page 4.2.24A PARTS FOR A MOON-PHASE CLOCK.**

4. **Have the students demonstrate how their Moon-Phase Clock operates.**

   Ask such questions as
   - How do we tell the time with our clock? (Because this is a sun clock, the sun hand will always point to the time.)
   - When is it night and when is it day? (Work to the idea that it is day when the sun is between its sunrise and sunset hours, approximately 0600 hours through 1800 hours. Night is the remainder of the time.)

- How many days does it take to go through all of the phases of the moon? (Work toward agreement that it takes between 29 and 30 days.)
- What would be the position of the hands of the Moon-Phase Clock at the new moon? (Have the students set the hands so that the moon and sun are rising and setting together. See Figure 4.2.14(2).)
- After the new moon, does the moon rise before or after the sun? (Work toward agreement that it rises after.)
- Where would the first crescent moon be in relation to the sun? (Work toward agreement that it will follow the sun.)
- What does our Moon-Phase Clock tell us about how long the moon will be in the night and day sky? (Use a quarter moon as an example. Work toward agreement that the moon follows the sun at an angle of about 90°. It will be in the sky about half the time when the sun is up and half the time when the sun is down. Use other examples as needed; for example, at the full moon it will be in the sky all night.)

5. **Have the students use a hands-and-head model to show the relative positions of the sun and moon during the major phases of the moon. See Figure 4.2.14(3).**

Have the students

- Stand and face north with their right hand extended to the east to hold the rising sun.
- Start with the new moon. Put the moon in their left hand and bring it over so that it is in the east with the sun at sunrise.
- Demonstrate how the two will travel across the sky together and set about the same time.
- Go through the other phases showing the position of the moon and the sun at sunrise. (Each day the moon will rise later and later. The students can verify this using the Moon-Phase Clock.)

6. **Have the students make generalizations about the hands-and-head simulation and the use of the Moon-Phase Clock.**

Ask such questions as

- Where is the sun in relation to the moon throughout the 24-hour day-and-night period when the moon is new? (The sun and moon will be together. See Figure 4.2.24(5).)
- Where is the sun in relation to the moon throughout the 24-hour day-and-night period when the moon is a crescent? (The sun is

close to the moon. The moon rises after sunrise when the moon is **waxing**, or getting larger. It rises before sunrise when the moon is **waning**, or getting smaller)

- Where is the sun in relation to the moon throughout the 24-hour day-and-night period when the moon is at the first quarter? (The sun is about 90° ahead of the moon.)
- Where is the sun in relation to the moon throughout the 24-hour day-and-night period when the moon is waxing gibbous? (The sun is more than 90° and less than 180° ahead of the moon when the moon is waxing.)
- Where is the sun in relation to the moon throughout the 24-hour day-and-night period when the moon is full? (It's about 180° ahead of the moon.)

7. **Prepare the students for another set of observations.**

Ask such questions as

- What way does the bright side of the moon face as it goes through its cycle? (List the students' hypotheses.)
- Do the "horns" of the crescent moon always point in the same direction? (Record their hypotheses.)
- How could we set up a test of our answers? What must we record? (Help the students see that they will need to show whether the horns are facing up, down, east, or west at different times during the day. Have them mark a time on their calendar when they will report on their findings.)

8. **After another cycle, analyze the data to see whether the students' hypotheses have been supported. Lead the students to see that the bright bulge always faces the sun and the horns point away from the sun.**

9. **Discuss the source of the moon's light.**

Ask such questions as

- Where does the moon seem to get its light?
- Why do you think so? (Work through the idea that the moon has no light when it rises with the sun. The moon cannot be its own source of light or we would see it as a full moon all of the time. Its full light is seen only at full moon when the sun is in the opposite direction from the moon. Therefore, the moon seems to get its light from the sun.)

10. **Use an overhead projector to simulate the light of the sun and a ball to represent the moon.**

    Have the students demonstrate their ideas of how the moon and the sun might interact to produce moon phases. See Figure 4.2.24(4) for one view.

11. **Review the models. Have the students use Student Page 4.2.24B MOON PHASES AND THE SUN to write an explanation of how the phases of the moon are produced. Have them use diagrams.**

EXTENSION

- On a day when the moon is out, hold a basketball at arm's length and place it so that it covers the moon. The students will see the sun lighting the same parts of the ball as the part of the moon they are viewing.

LENGTH OF DAY GRAPH

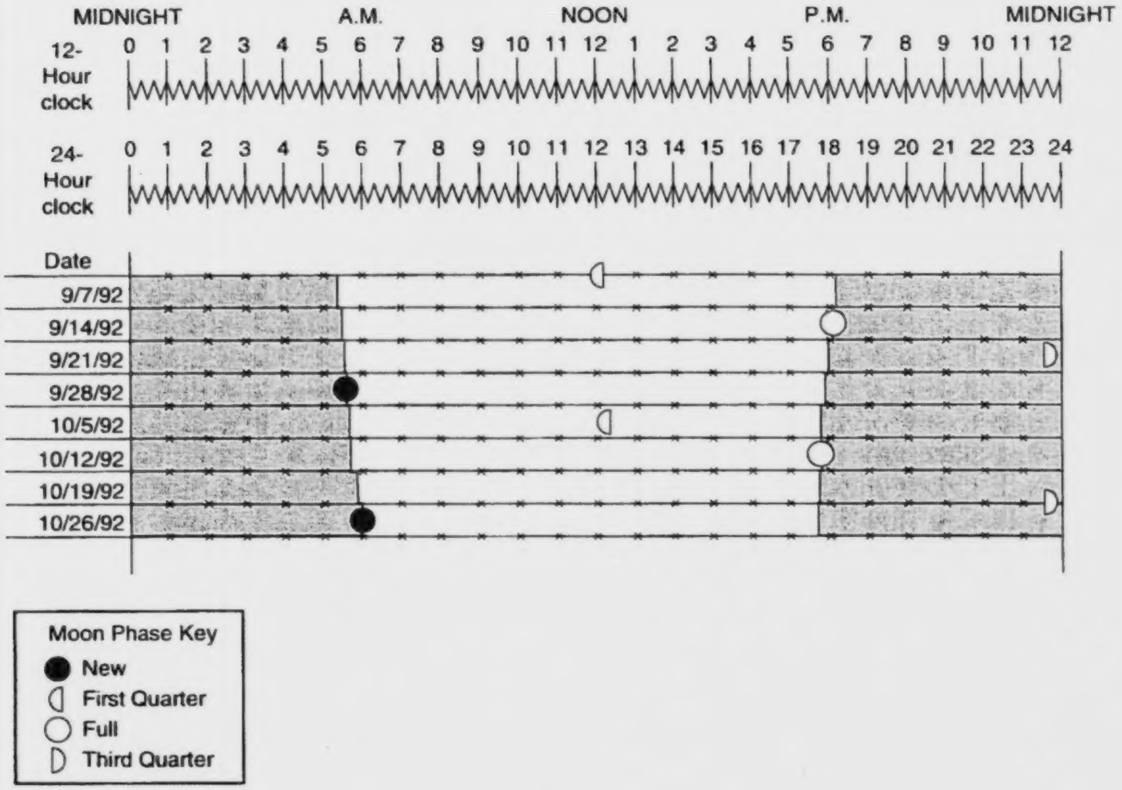
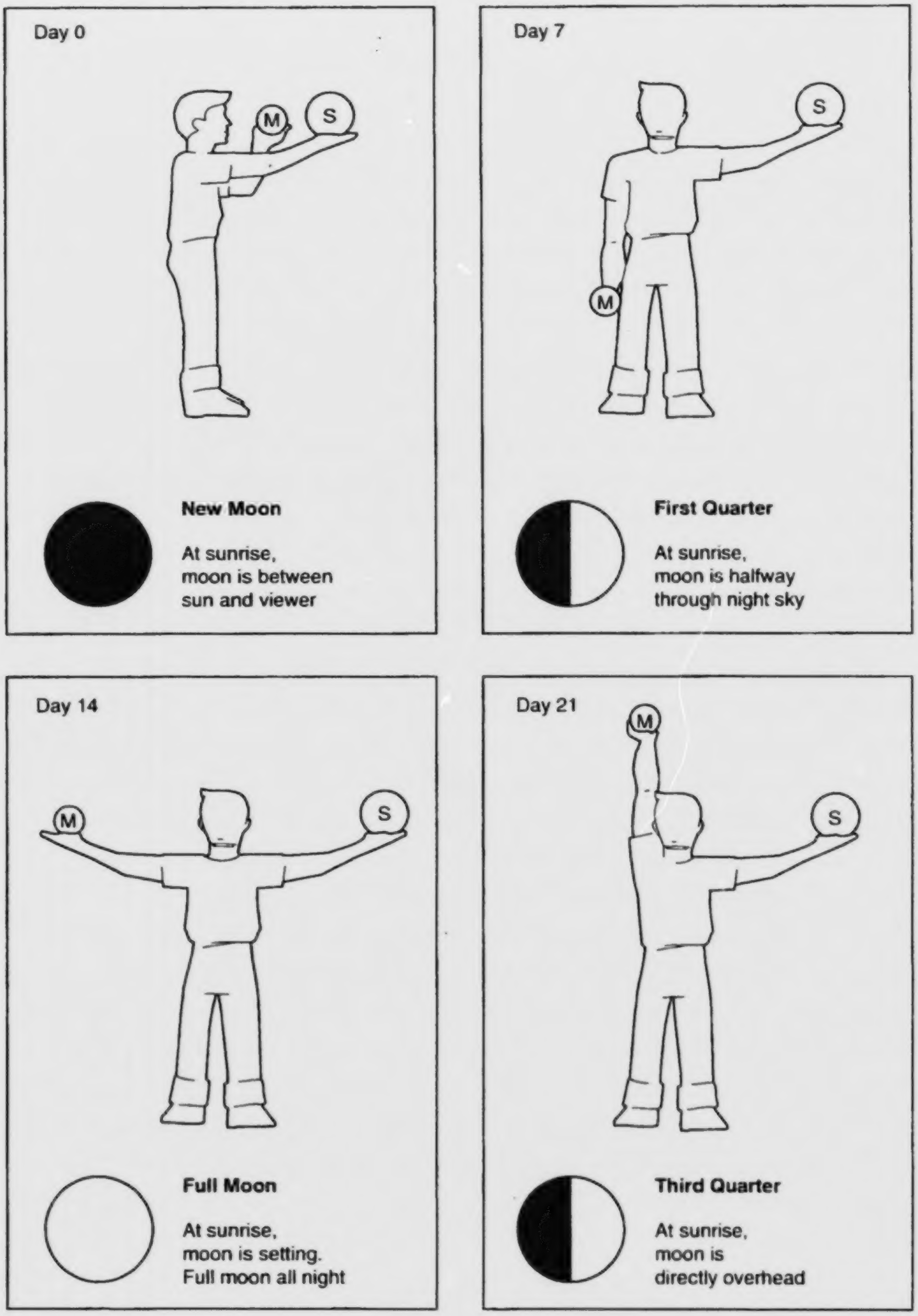


Figure 4.2.24(1) Example of moonrise data superimposed on Length of Day Graph



New Moon

At sunrise,
moon is between
sun and viewer

First Quarter

At sunrise,
moon is halfway
through night sky

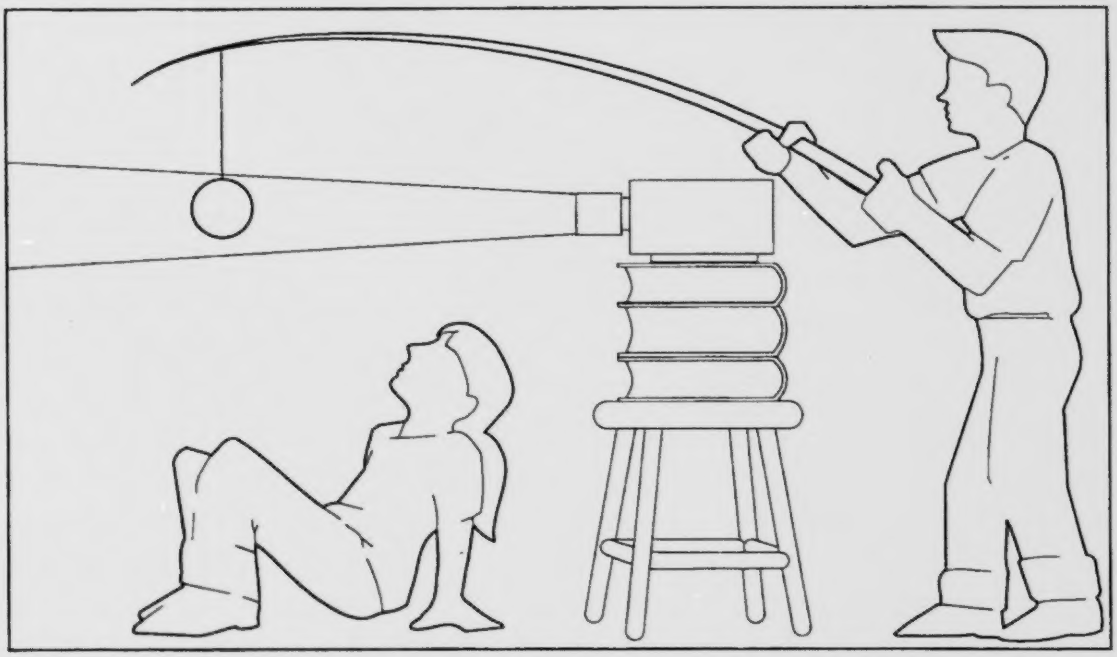
Full Moon

At sunrise,
moon is setting.
Full moon all night

Third Quarter

At sunrise,
moon is
directly overhead

Figure 4.2.24(2) Hands-and-head model of moon phases



Ball Simulation of the Moon Phases

Use a slide projector for the sun.
Suspend a ball in the light beam for the moon.
Sit below the light beam and look up.

Figure 4.2.24(3) Ball simulation of moon phases

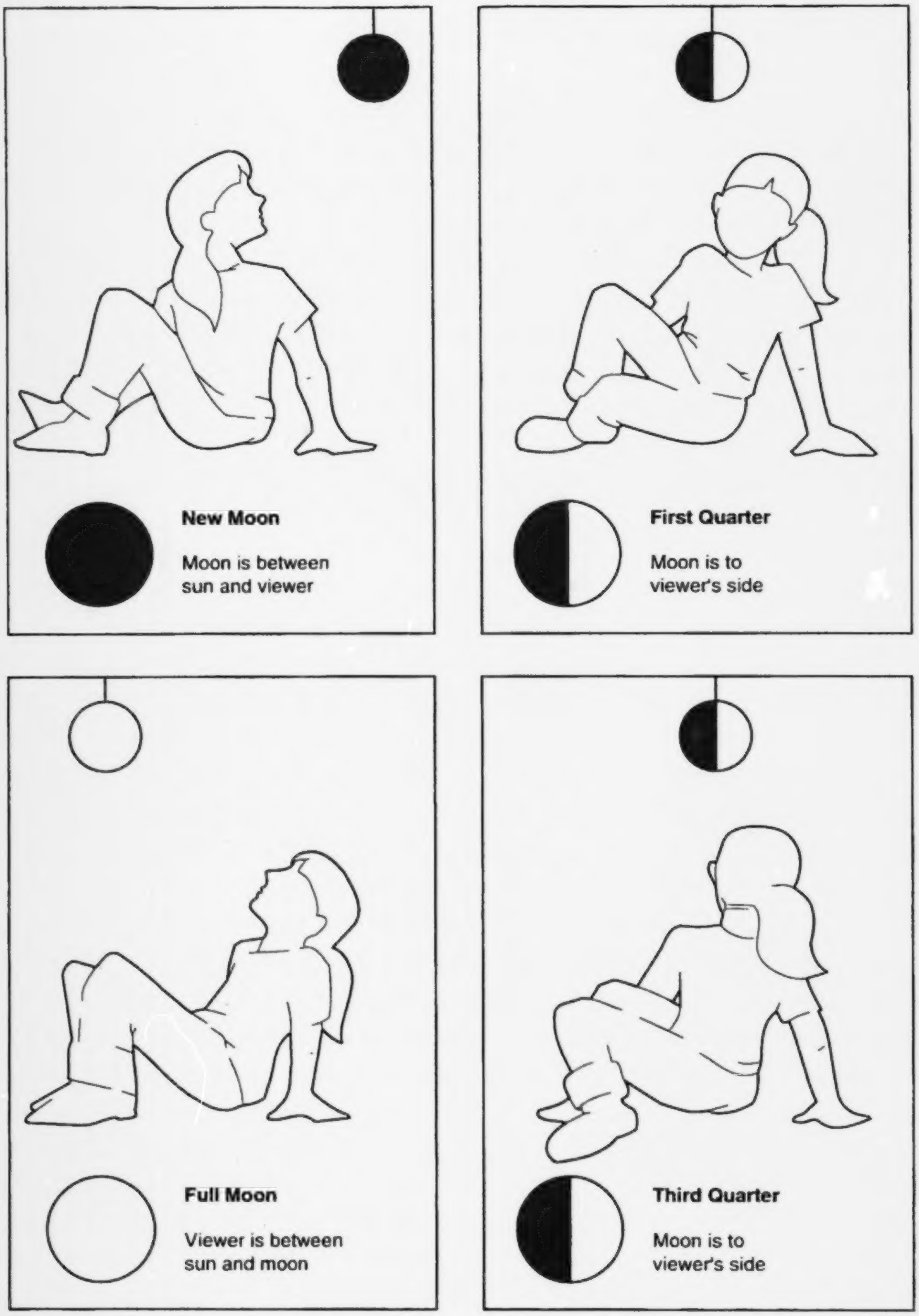

New Moon
Moon is between sun and viewer
First Quarter
Moon is to viewer's side
Full Moon
Viewer is between sun and moon
Third Quarter
Moon is to viewer's side

Figure 4.2.24(4) Views of ball simulation from sitting position

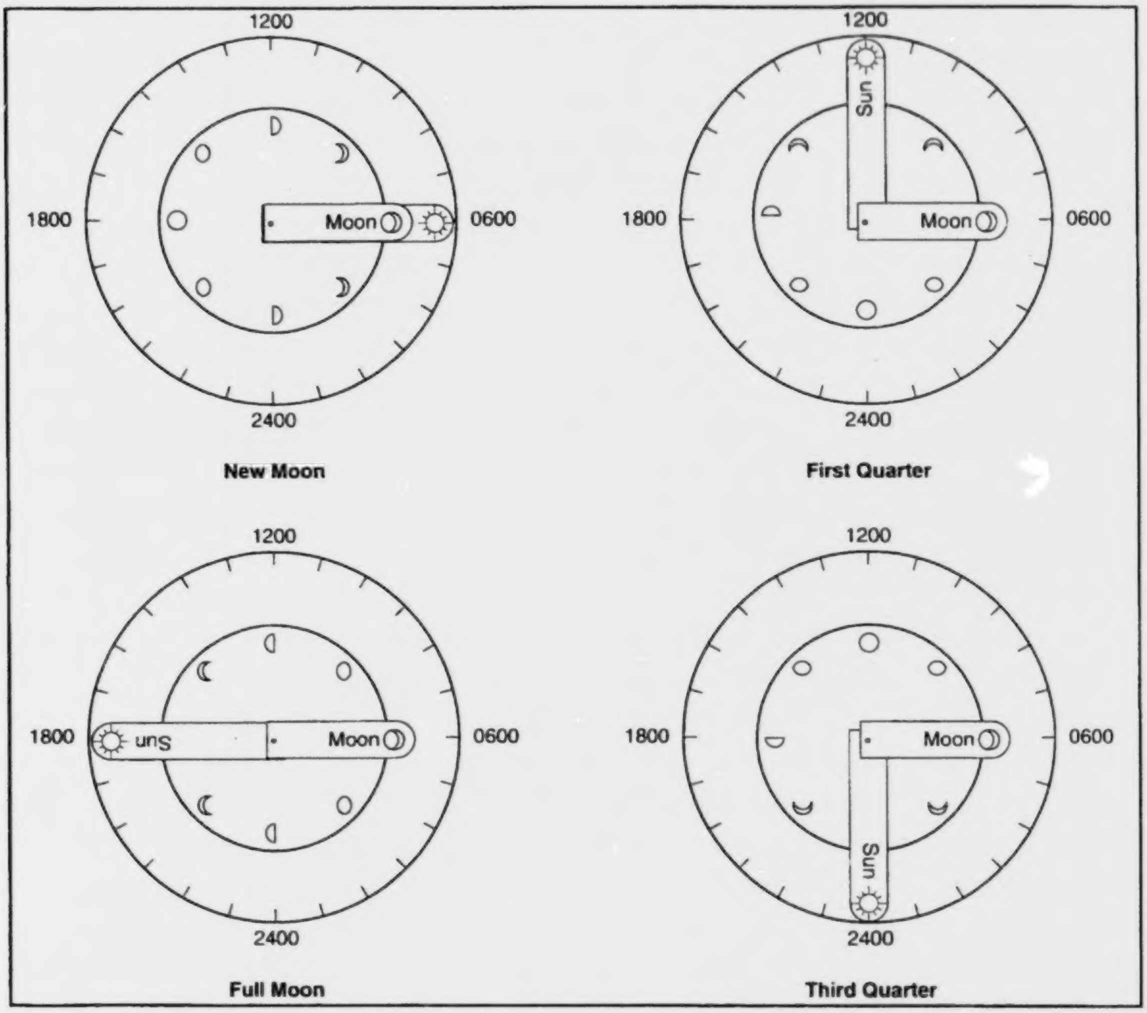

1200
1800
0600
2400
Moon
New Moon
1200
Sun
1800
Moon
0600
2400
First Quarter
1200
1800
Sun
Moon
0600
2400
Full Moon
1200
1800
Moon
0600
Sun
2400
Third Quarter

Figure 4.2.24(5) Moon-Phase Clock showing position of hands at the four major moon phases

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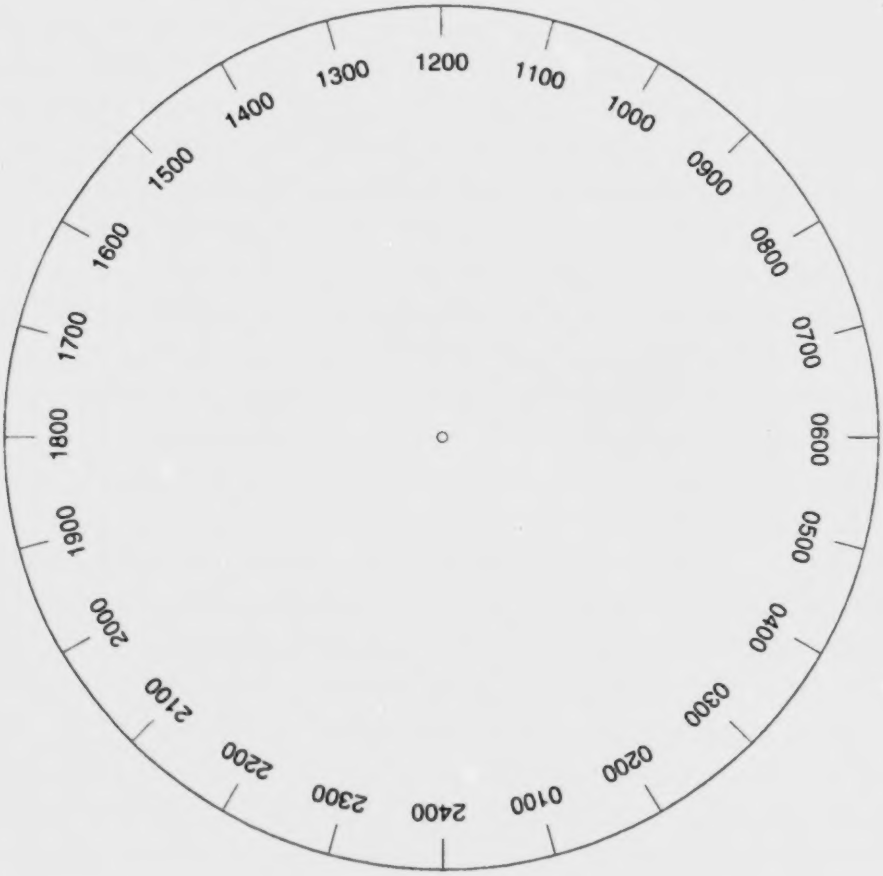
DASH

Name_________________________

Date_________________________

STUDENT PAGE 4.2.24A PARTS OF A MOON-PHASE CLOCK

Cut out and assemble the parts to make a Moon-Phase Clock.


1200
1100
1000
0900
0800
0700
0600
0500
0400
0300
0200
0100
2400
2300
2200
2100
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1900
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1700
1600
1500
1400
1300

Figure SP 4.2.24A(1) Time circle

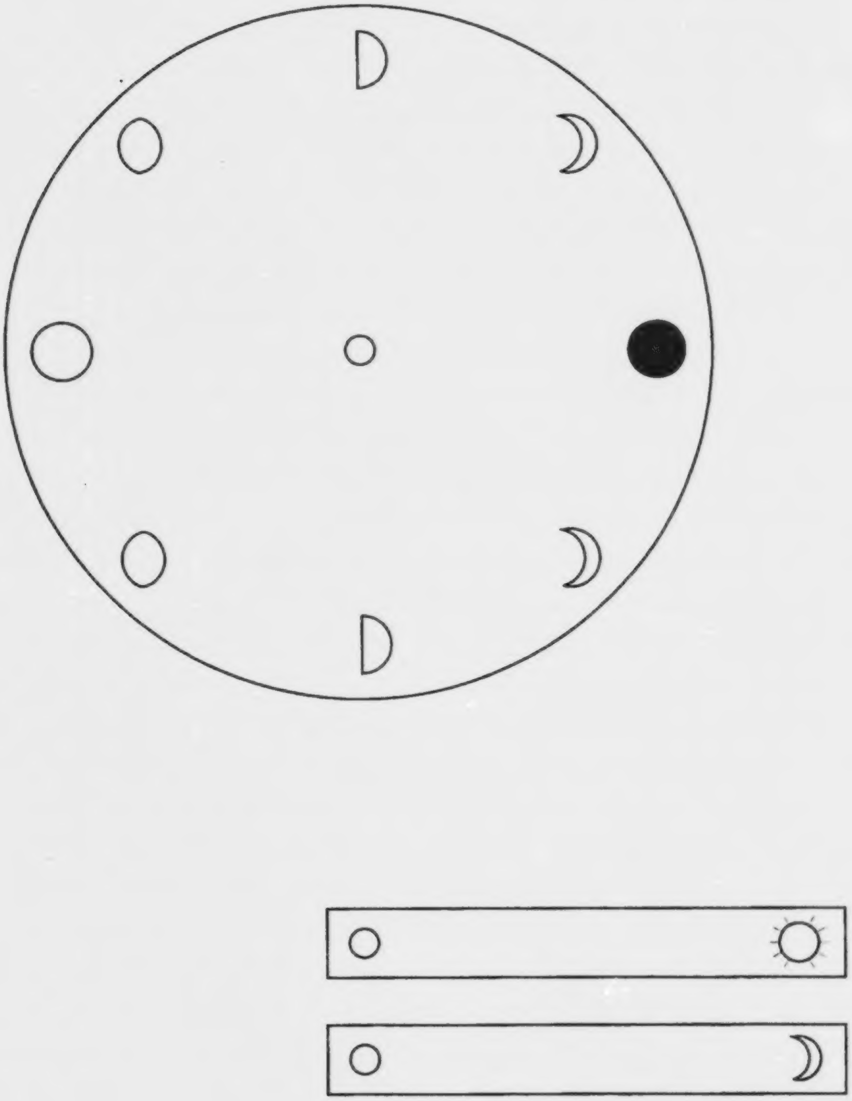


Figure SP 4.2.24A(2) Moon phases and sun and moon hands

Name________________________

Date________________________

DASH

STUDENT PAGE 4.2.24B MOON PHASES AND THE SUN

Use diagrams and explain how moon phases are produced.

ACTIVITY 4.2.25 ECLIPSES

OBJECTIVES

The students
- Build a camera obscura or other sun-viewing device.
- Devise ways to observe, draw, and time lunar eclipses.
- Use their devices to observe, draw, and time solar and lunar eclipses.
- Explain how lunar and solar eclipses occur.

BACKGROUND

In this activity the students build devices for observing and timing eclipses of the sun and moon.

Eclipses of the Sun (Solar Eclipses)

Solar eclipses are produced at the time of the new moon when the moon passes in front of the sun. When they are visible in the part of the world where you are, they will occur during daylight hours, often during school time. Alignment of the sun and the moon so that the sun is completely blocked is rare. Such events are called **total eclipses**. However, **partial eclipses,** when the moon covers only part of the sun's disk, are relatively common, and during the years when the students are in elementary school, they will have several opportunities to observe them. To observe the moon fully covering the sun, one must be in direct alignment with both the sun and the moon. The path of alignment will be quite narrow. Observers on either side of the path of alignment will see a partial eclipse. Information on where and when eclipses will occur can be found in almanacs.

Eclipses of the Moon (Lunar Eclipses)

Lunar eclipses are produced at the time of the full moon when Earth passes between the sun and the moon. Visible lunar eclipses occur during night hours. As with solar eclipses, alignment of the sun, Earth, and the moon for a total eclipse of the moon is rare; however, partial lunar eclipses are common.

Viewing Eclipses of the Sun

One technique for viewing solar eclipses is to use a camera obscura. The camera obscura is a pinhole camera and will provide a sharp image no matter what its focal length. Because the sun casts an image on the back of the camera, the image can be traced on paper. The longer the camera, the larger the image. By using a large box, the students can put their head and hands inside for viewing and drawing. Provision should be made to keep out all light that doesn't come through the pinhole. This can be done by using a drape over the observer and covering light spaces with duct tape or stuffing them with paper.

The students should be reminded that the camera can be aligned with the sun by using a shadow stick or gnomon. The camera should be lined up so that its base rests along the shadow line and the pinhole is pointed to the sun. See Figure 4.2.25(1). It may be necessary to enlarge the pinhole with a pencil point to see a bright image.

There are other ways an eclipse of the sun can be viewed. With some there is the risk that students will look directly at the sun and perhaps damage their eyes.

Viewing Eclipses of the Moon

The moon can be looked at directly. Observation of eclipses of the moon can be recorded in several ways. Drawings can be made on acetate or cellophane sheets taped over a mirror or taped onto a glass window. A marking pen can be used. See Figure 4.2.25(2). Lunar and solar eclipses can also be photographed.

Hands-and-Head Model of Eclipses

After completing Activity 4.2.24 MOON PHASES AND THE SUN, the students can use the hands-and-head model from the activity to demonstrate alignment of Earth, the moon, and the sun at eclipses. Have the students use the new moon position to show alignment at a solar eclipse and the full moon position to show the alignment at a lunar eclipse.

STUDENT ROLE

Astronomer

MATERIALS

Large cardboard box for the camera obscura
Duct tape to make the box lightproof
Sheets of cardboard
Broomstick 1/2 to 1 meter long to act as a gnomon
Hammer
Heavy dark cloth to exclude light
Drawing pens
Acetate or cellophane sheets

Plastic tape.
Watch
Student Page 4.2.25 ECLIPSES

PROCEDURES

1. **Have the students watch the papers and look in almanacs to find when the next solar and lunar eclipses will be visible.**

2. **Review the students' experience with a solar eclipse.**

   Ask such questions as
   - How could you tell when the eclipse started?
   - How could you tell when the eclipse ended?
   - How long did the eclipse take?
   - How much of the sun was covered at the maximum point of the eclipse?
   - How did this eclipse compare with other eclipses you have observed?
   - What, if any, seems to be the relationship between an eclipse of the sun and the phase of the moon?

3. **Have the students invent a way to view and draw the stages of an eclipse of the moon.**

   This might involve using
   - A camera.
   - A system using a mirror or window glass.

4. **Have the students construct a device for viewing the sun so that they can draw the stages of an eclipse.**

5. **Before an eclipse is expected, have the students practice using their devices and have them demonstrate to the class what they have done.**

6. **Have the students use Student Page 4.2.25 ECLIPSES to assemble a record of past and present eclipses and to make diagrams of the alignment of the sun, moon, and Earth during eclipses.**

Ask such questions as
- Where are the moon, Earth, and sun during a solar eclipse? (Work toward agreement that the moon is between Earth and the sun.)
- What creates the shadow in a lunar eclipse? (Work toward agreement that the moon blocks the sunlight.)
- What is the phase of the moon in a solar eclipse? (Work toward agreement that it is always a new moon.)
- What creates the shadow? (Work toward agreement that Earth blocks the sunlight.)
- What is the phase of the moon in a lunar eclipse? (Work toward agreement that it is always a full moon.)
- Is there a relationship between lunar and solar eclipses? (They seem to come about 15 days apart.)

7. **Have the students construct working definitions of lunar and solar eclipses in the Working Dictionary.**

Have them
- Record and discuss their definitions.
- Use the hands-and-head model to demonstrate the alignment of the sun, moon, and Earth after they have completed Activity 4.2.24 MOON PHASES AND THE SUN.

EXTENSIONS

Have the students
- Read about ways eclipses were viewed by people in times past.
- Find articles about why research scientists study eclipses.

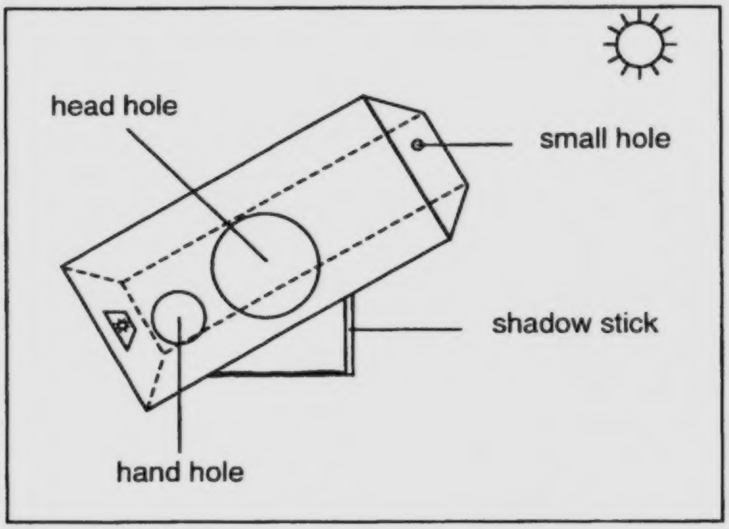

head hole
small hole
shadow stick
hand hole

Figure 4.2.25(1) A camera obscura aligned using a stick or gnomon

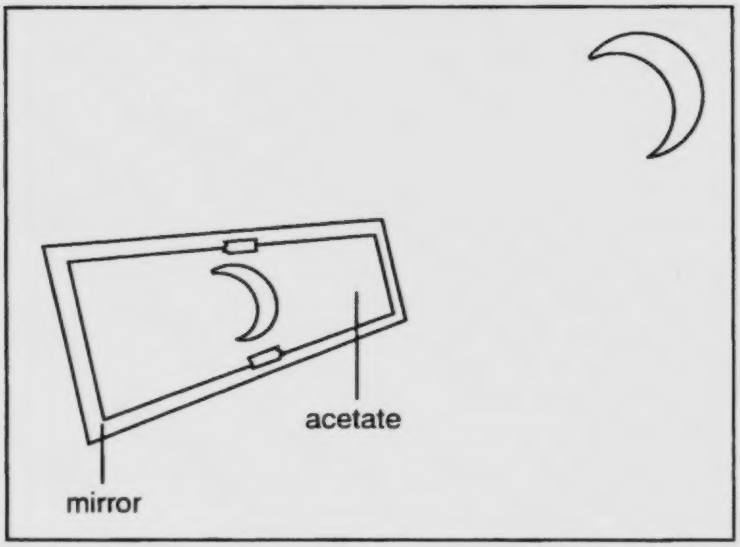

acetate
mirror

Figure 4.2.25(2) Using a mirror to trace the image of the moon

Name____________________

Date____________________

STUDENT PAGE 4.2.25 ECLIPSES

1. Use the table below to record your data on each eclipse you observe.

Kind of eclipse	Date of eclipse	Time eclipse began	Time eclipse ended	Phase of moon

2. Describe how the sun, Earth, and the moon seem to be aligned during eclipses of the sun. Suggest what seems to create the shadow.

____

____

____

____

____

____

3. **Use diagrams to show the alignment of the sun, Earth, and moon during an eclipse of the sun.**

4. **Describe how the sun, Earth, and the moon seem to be aligned during eclipses of the moon. Suggest what seems to create the shadow.**

5. **Use diagrams to show the alignment of the sun, Earth, and moon during eclipses of the moon.**

Name________________________

Date________________________

DASH

STUDENT PAGE 4.2.1A RAINFALL

1. Draw and label a diagram of your rain gauge.

2. Explain how your rain gauge works.

DASH

STUDENT PAGE 4.2.1B
PRECIPITATION RECORD

Name ____________________

Date ____________________

MONTH ________ YEAR_____

DATE	1	2	3	4	5	6	7	8	9	10	11	TOTALS	
Snowfall (cm)													▨
Snow water (cm)												▨	
Rainwater (cm)												▨	
DATE	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**			
Snowfall (cm)											▨		▨
Snow water (cm)											▨	▨	
Rainwater (cm)											▨	▨	
DATE	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**			
Snowfall (cm)											▨		▨
Snow water (cm)											▨	▨	
Rainwater (cm)											▨	▨	
							Total snowfall (cm)						▨
							Total water (cm)					▨	

DASH

Name__________________________

Date___________________________

STUDENT PAGE 4.2.2 SNOWFALL

1. **Draw and label a diagram of a snow gauge.**

2. **Explain how the snow gauge works.**

____

____

____

3. **State your research questions and how you collected your data. Record your data and give your interpretation.**

____

____

____

____

____

____

____

Name________________________

Date________________________

STUDENT PAGE 4.2.3 WIND DIRECTION

1. **Draw and label a diagram of your wind direction indicator and explain how it works.**

2. **State your research question. Tell how you collected your data and how you interpreted it.**

Name________________________

Date________________________

STUDENT PAGE 4.2.4A BEAUFORT SCALE

Scale No.	Miles/ hour	Km/ Hour	Indicators	Kind of Wind
0	.0 to 0.9	.0 to 1.5	Smoke goes straight up	Calm
1	1.0 to 3.9	1.6 to 6.5	Smoke drifts sideways	Light air
2	4.0 to 7.9	6.6 to 12.5	Leaves rustle	Slight breeze
3	8.0 to 12.9	12.6 to 20.5	Leaves and twigs move	Gentle breeze
4	13.0 to 18.9	20.6 to 30.5	Small branches move; dust, paper fly	Moderate breeze
5	19.0 to 24.9	30.6 to 40.5	Water ripples; small trees sway	Fresh breeze
6	25.0 to 31.9	40.6 to 51.5	Large branches move	Strong breeze
7	32.0 to 38.9	51.6 to 62.5	Trunks of trees bend; walking difficult	High wind
8	39.0 to 46.9	62.6 to 75.5	Twigs break off	Gale
9	47.0 to 54.9	75.6 to 87.5	Shingles carried away	Strong gale
10	55.0 to 63.9	87.6 to 104.5	Trees uprooted	Whole gale
11	64.0 to 72.9	104.6 to 116.7	Widespread damage	Windstorm
12	73.0 to	116.6 to	General disaster	Hurricane Tornado

Name________________________

Date_________________________

DASH

STUDENT PAGE 4.2.4B WIND SPEED

1. List your questions about wind speed.

2. Give answers to your questions and explain how you got them.

Name__________________________

Date___________________________

DASH

STUDENT PAGE 4.2.5
ALTITUDE TABLE WITH LANDMARK AT 3 KM

Fill in the missing data

High Clouds

Above 7 km
Above 66°

Above _________ fists

Middle Clouds

3-7 km
between 45° and 66°

Between _________ and
fists

Low Clouds

1-3 km
up to 45°

Up to _________ fists

Object at eye level _________

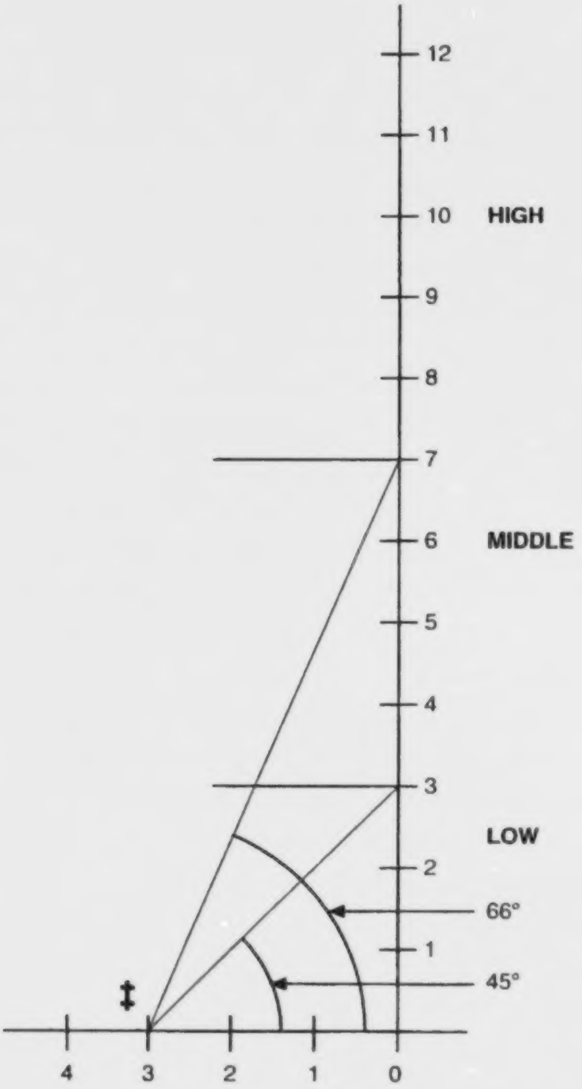

12
11
10
HIGH
9
8
7
6
MIDDLE
5
4
3
LOW
2
66°
1
45°
4
3
2
1
0

Figure SP 4.2.5 Altitude table with landmark at 3 km

DASH

Name______________________

Date______________________

STUDENT PAGE 4.2.6 HUMIDITY

1. Explain how the class made its humidity gauge.

____

____

____

____

____

____

2. Explain how the humidity gauge works.

____

____

____

____

____

____

3. Explain how humidity seems to be related to comfort.

____

____

____

____

____

____

DASH

STUDENT PAGE 4.2.7 FAIR-WEATHER CLOUDS

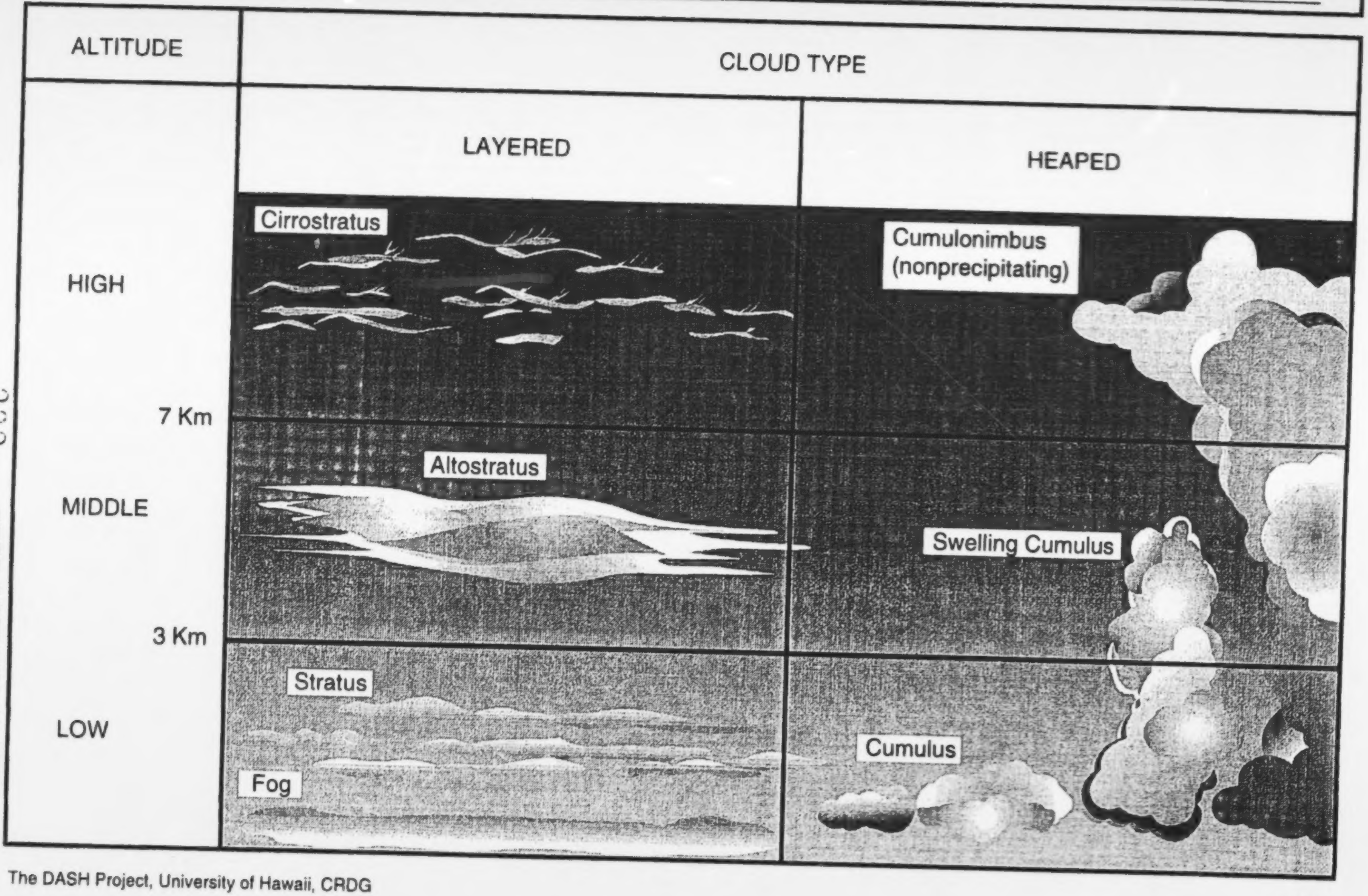
Name ____________________

Date ____________________

DATE	TIME	TEMP °C	COLOR	COLOR	HT	DRAWING	MOVEMENT DIRECTION

SP 4.2.8A LAYERED AND HEAPED CLOUDS

Name ____________________
Date ____________________


ALTITUDE
CLOUD TYPE
LAYERED
HEAPED
HIGH
7 Km
MIDDLE
3 Km
LOW
Cirrostratus
Cumulonimbus
(nonprecipitating)
Altostratus
Swelling Cumulus
Stratus
Fog
Cumulus

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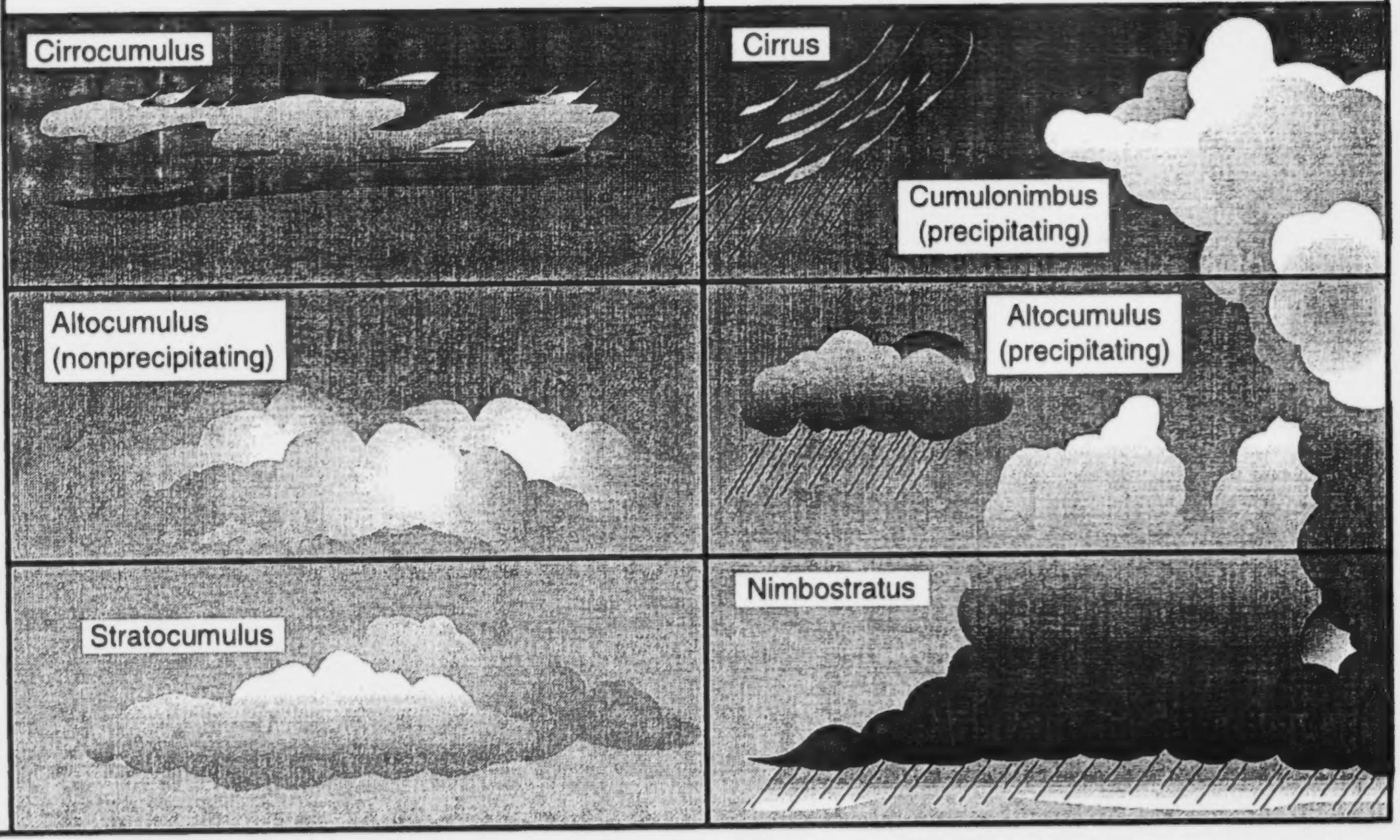
SP 4.2.8B COMBINATION AND PRECIPITATING CLOUDS

Name ______________________

Date ______________________

ALTITUDE	CLOUD TYPE	
	COMBINATION	PRECIPITATING
HIGH		
7 Km		
MIDDLE		
3 Km		
LOW		


Cirrocumulus
Cirrus
Cumulonimbus (precipitating)
Altocumulus (nonprecipitating)
Altocumulus (precipitating)
Stratocumulus
Nimbostratus

333

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STUDENT PAGE 4.2.8C STORM CLOUDS

Name ____________________

Date ____________________

DATE	TIME	TEMP °C	COLOR	SIZE	DRAWING	HT	MOVEMENT DIRECTION	PRECIPITATION

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DASH

Name________________________

Date________________________

STUDENT PAGE 4.2.9 THE LIGHTNING QUIZ

Check all of the statements that correctly complete the statement.

1. Lightning
    - _____is a very big electrical spark
    - _____travels in a straight line.
    - _____kills several hundred people every year in our country.
    - _____that strikes the ground comes mostly from very high clouds.
2. Thunder
    - _____is produced when clouds bump together.
    - _____is produced when the air is suddenly heated by lightning.
    - _____is very dangerous if it hits you.
    - _____is only noise.
3. Thunderstorms
    - _____are most common in the winter.
    - _____may occur in the clouds and not involve the ground.
    - _____are most dangerous at night.
    - _____are more common in the Rockies, Midwest, and Florida than in other parts of the country.
4. In a thunderstorm it is usually safe to
    - _____stay in a car.
    - _____be in a concrete and steel building.
    - _____stand in the middle of a field.
    - _____be in an airplane.
    - _____be in a house without a lightning rod.
    - _____stay under trees in an open field.
5. Lightning
    - _____may be hotter than the surface of the sun.
    - _____tends to strike the highest object below the cloud from which it comes.
    - _____can be safely detected by flying a kite into a storm.
    - _____can strike a power line and burn out electronic equipment.

DASH

Name__________________________

Date__________________________

STUDENT PAGE 4.2.10 WEATHER PREDICTIONS

MONTH/YEAR	WEATHER PREDICTED	CHECK IF CORRECT

DASH

STUDENT PAGE 4.2.11 WEATHER FRONTS

Name ____________________

Date ____________________

DATE	TIME	FRONT TYPE (Cold or Warm)	WIND SPEED	WIND DIRECTION	CLOUD DIRECTION	CLOUD TYPE	TEMP °C	PRECIPITATION

DASH

STUDENT PAGE 4.2.12
AFTERNOON WEATHER

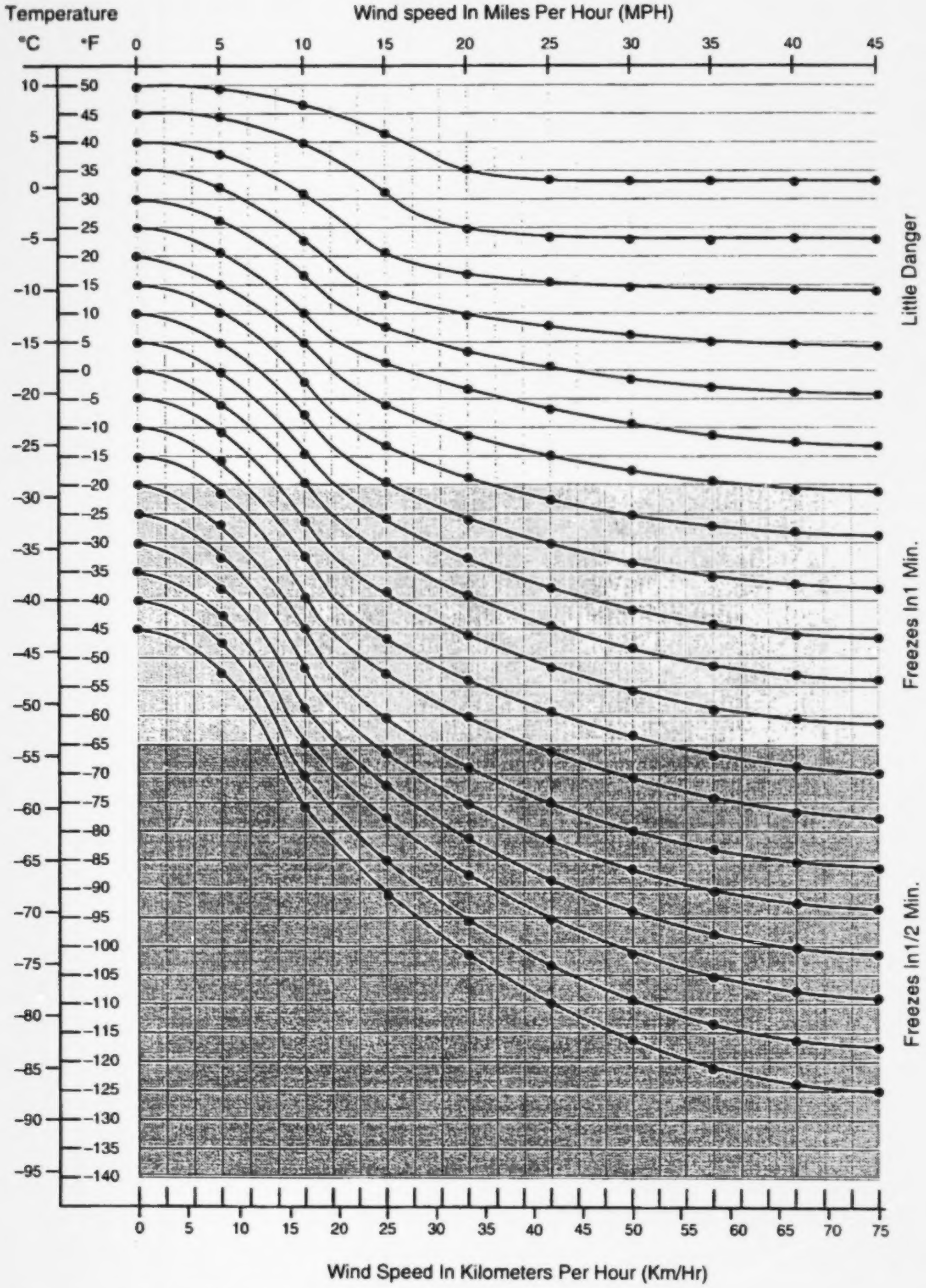
Name ____________________

Date ____________________

DATE	NEWSPAPER PREDICTIONS	CHECK IF CORRECT	MY OWN PREDICTIONS	CHECK IF CORRECT

DASH	SP 4.2.13A WIND CHILL CHART	Name ______ Date ______

WIND CHILL CHART
(APPARENT TEMPERATURE)



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Name________________________

Date________________________

STUDENT PAGE 4.2.13B USING THE WIND CHILL CHART

1. Make up a set of instructions for using the Wind Chill Chart. Include one or two examples of how to use the chart.

2. Explain how wind lowers the temperature of things that are wet.

DASH

Name__________________________

Date__________________________

STUDENT PAGE 4.2.14 FLAT OR ROUND EARTH?

1. Use straight lines to draw a figure that looks like a circle.

2. List the evidence that we have that Earth is not shaped like a globe.

____

____

____

____

____

3. List the evidence we have that Earth is shaped like a globe.

____

____

____

____

____

DASH	**SP 4.2.15A** **LENGTH OF DAY GRAPH**																								

Name ____________________

Date ____________________

	Midnight						**a.m.**						**Noon**						**p.m.**						**Midnight**
12-Hour Clock	0	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
24-Hour Clock	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

DATE

SP 4.2.15B
LENGTH OF NIGHT GRAPH

Name ____________________

Date ____________________

	Noon						**p.m.**						**Midnight**						**a.m.**					**Noon**
12-Hour Clock	0	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
24-Hour Clock	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7	8	9	10	11	12

DATE

Name________________________

Date________________________

DASH

STUDENT PAGE 4.2.16 THE SUN'S SHADOW PATH

Explain the relationship between the path of the sun and the seasons.

DASH

Name________________________

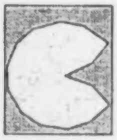
Date________________________

STUDENT PAGE 4.2.17A PERSONAL PLANETARIUM

Use the following instructions and the Planetarium Sheets to make a small personal planetarium.

- Glue the inside and outside together so that the same stars are directly on top of each other.
- Check the alignment by pressing a pin through 3 or 4 stars. If they are properly aligned, the pin will go through the same star on either side of the model.
- Cut out the planetarium along the heavy lines.
- Fold the planetarium into a six-sided tent using the dotted fold lines.
- Glue or tape the tabs between the two layers of the planetarium. If tape is used, the planetarium can be disassembled, folded flat, and stored.

DASH—*IN*



1 page

North Celestial Pole and Zodiac

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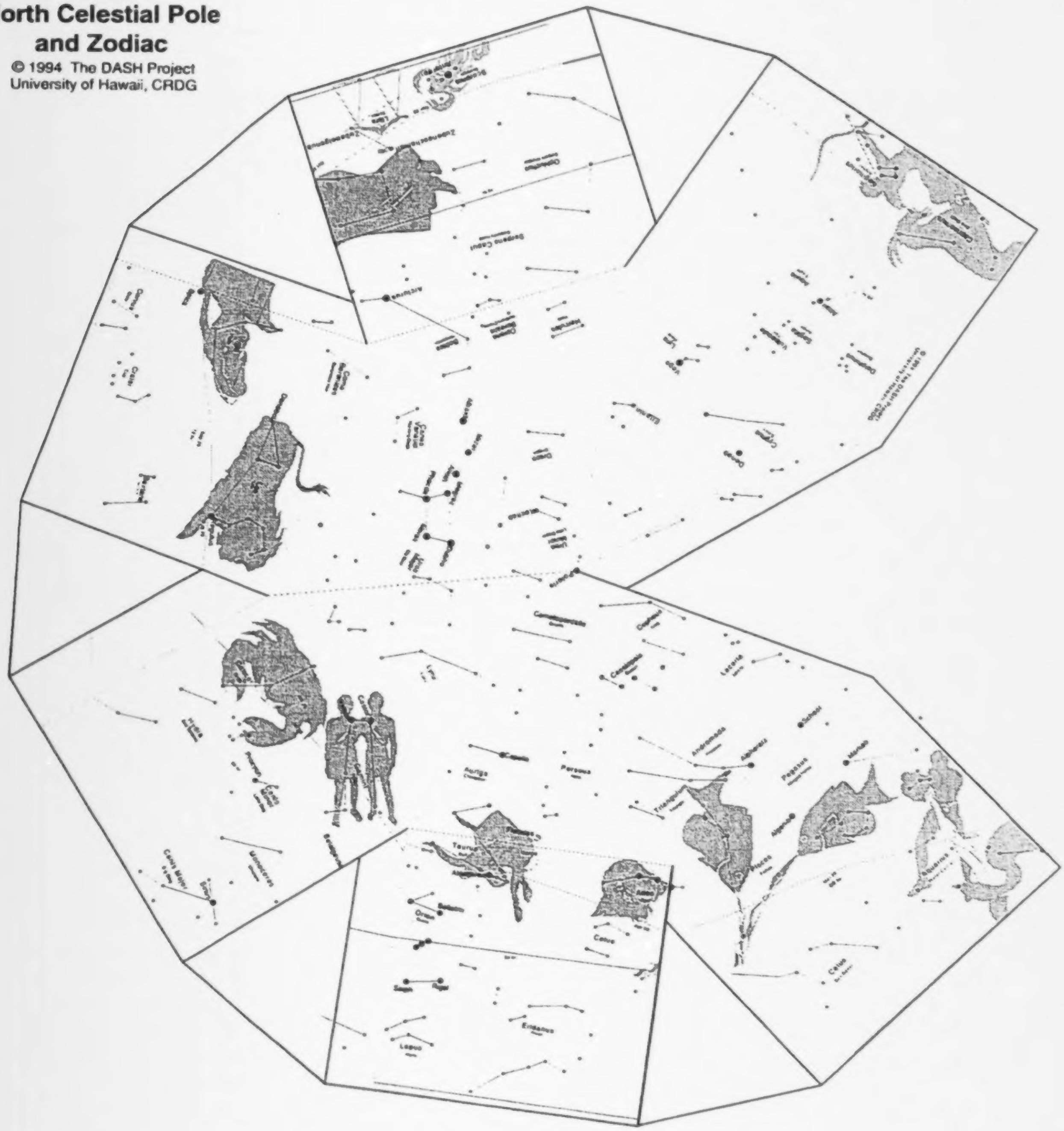

Serpens Caput
Ophiuchus
Cassiopeia
Cepheus
Lacerta
Andromeda
Pegasus
Triangulum
Perseus
Auriga
Pisces
Aquarius
Taurus
Cetus
Orion
Eridanus
Lepus
Canis Major
Monoceros

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DASH—*OUT*

1 page

North Celestial Pole and Zodiac

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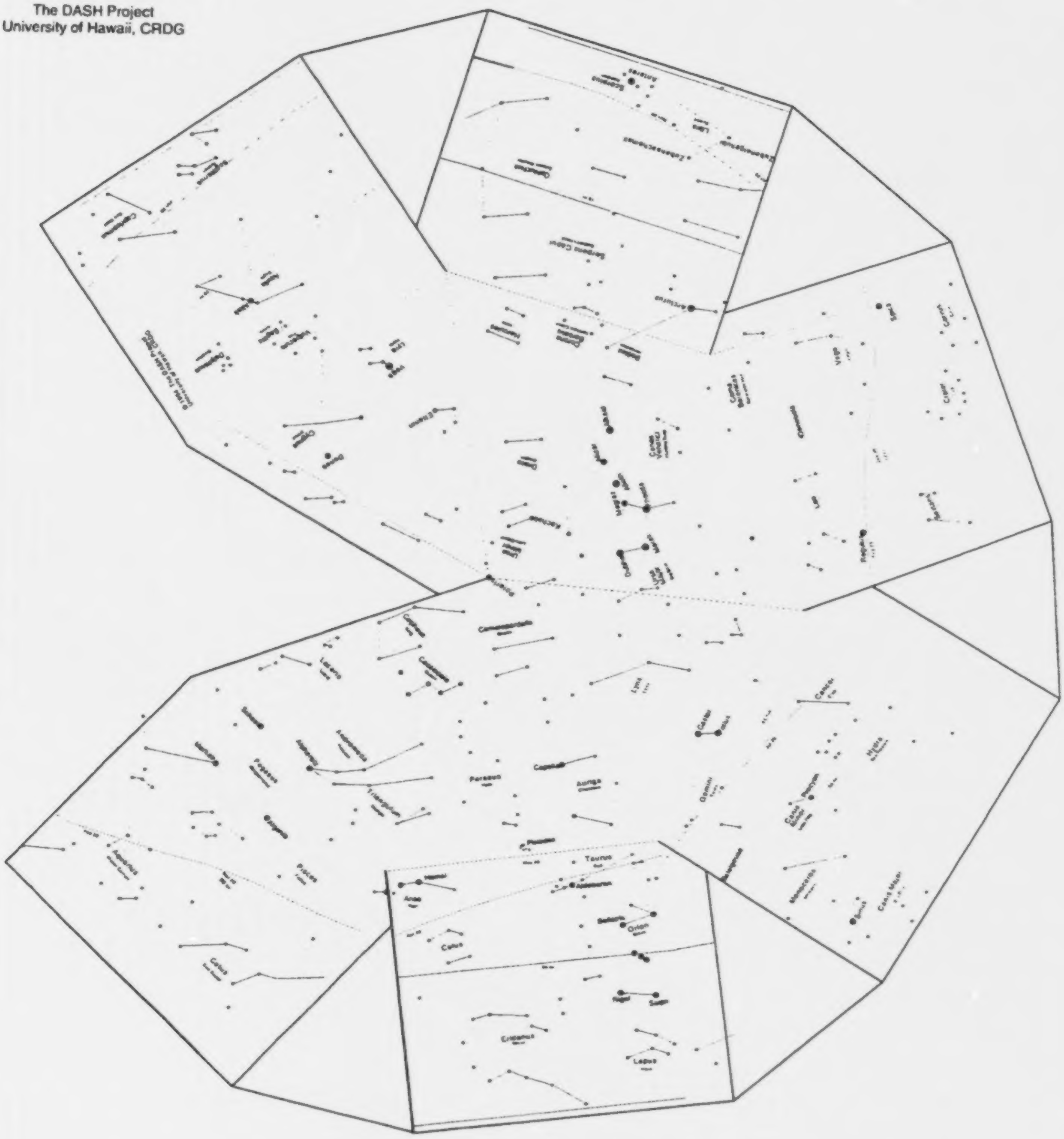
Serpens Caput
Arcturus
Spica
Virgo
Corvus
Crater
Coma Berenices
Canes Venatici
Leo
Regulus
Lynx
Cancer
Castor
Pollux
Gemini
Hydra
Procyon
Canis Minor
Monoceros
Sirius
Canis Major
Capella
Auriga
Perseus
Taurus
Aldebaran
Orion
Rigel
Eridanus
Lepus
Cetus
Aries
Triangulum
Andromeda
Pegasus
Pisces
Aquarius

347

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DASH

Name________________________

Date________________________

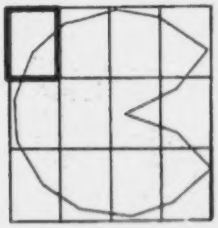
STUDENT PAGE 4.2.17B LARGE PLANETARIUM

Make a large model of the planetarium for the classroom. Use your personal model as a guide to assembling the large model.

- Glue the inside and outside together so that the same stars are directly on top of each other.
- Check the alignment by pressing a pin through 3 or 4 stars. If they are properly aligned, the pin will go through the same star on either side of the model.
- Cut out the planetarium along the heavy lines.
- Fold the planetarium into a six-sided tent using the dotted fold lines.
- Glue or tape the tabs between the two layers of the planetarium. If tape is used, the planetarium can be disassembled, folded flat, and stored.

CUT ALONG INSIDE OF DOTTED LINE

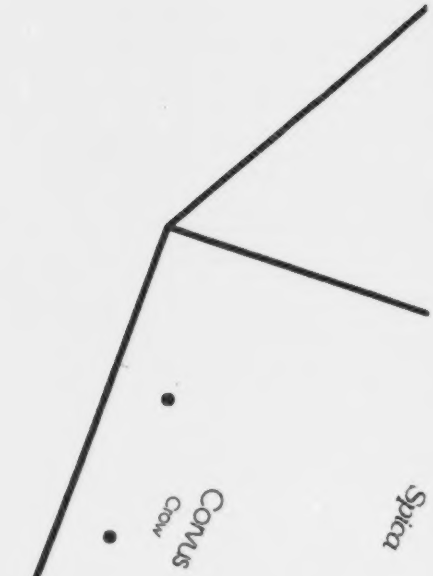
DASH—IN



12 pages

University of Hawaii, CRDG

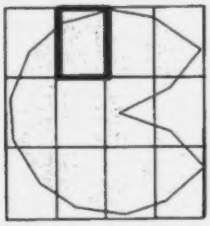
GLUE EDGE


Corvus
Crow
Spica

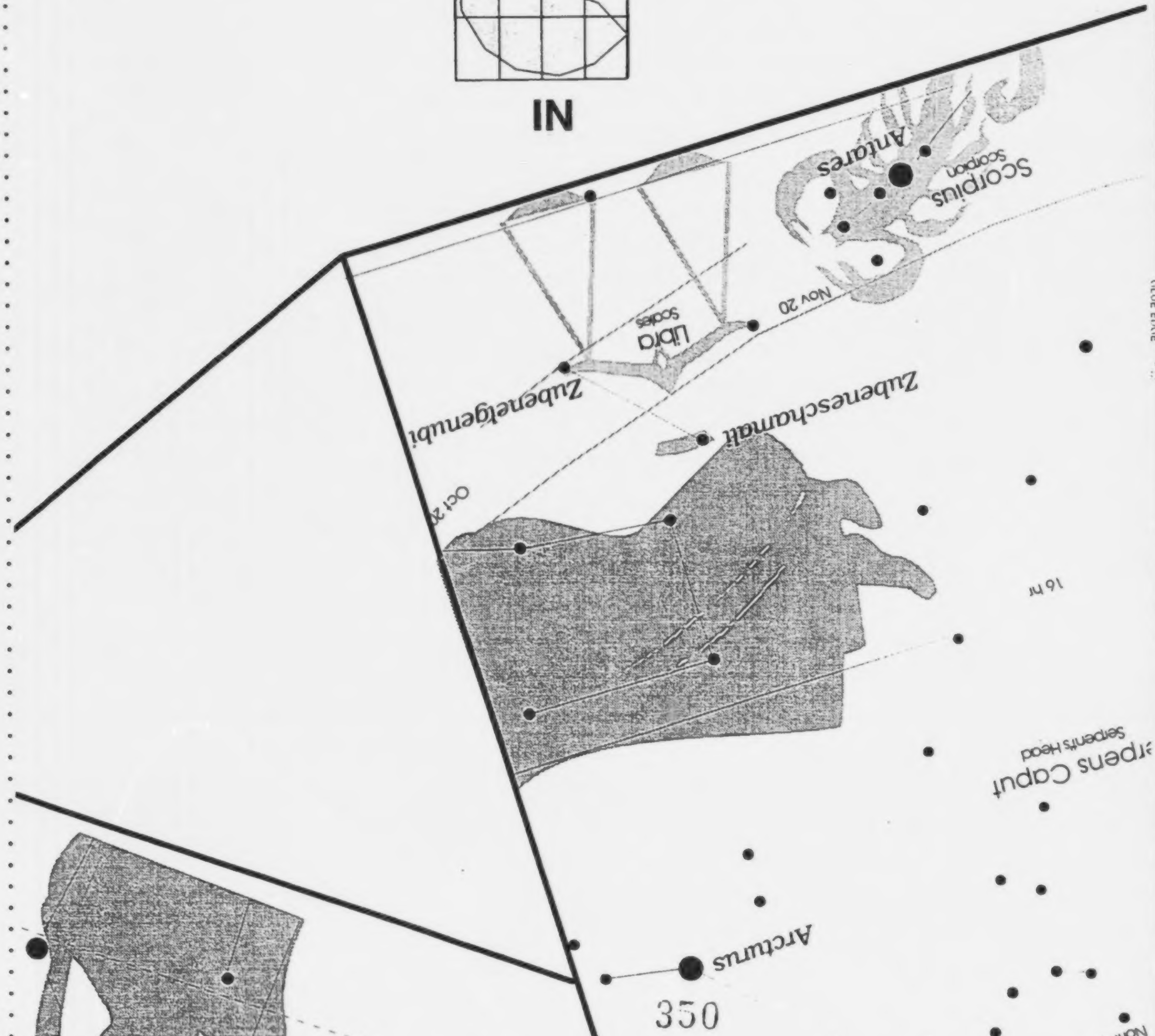
349

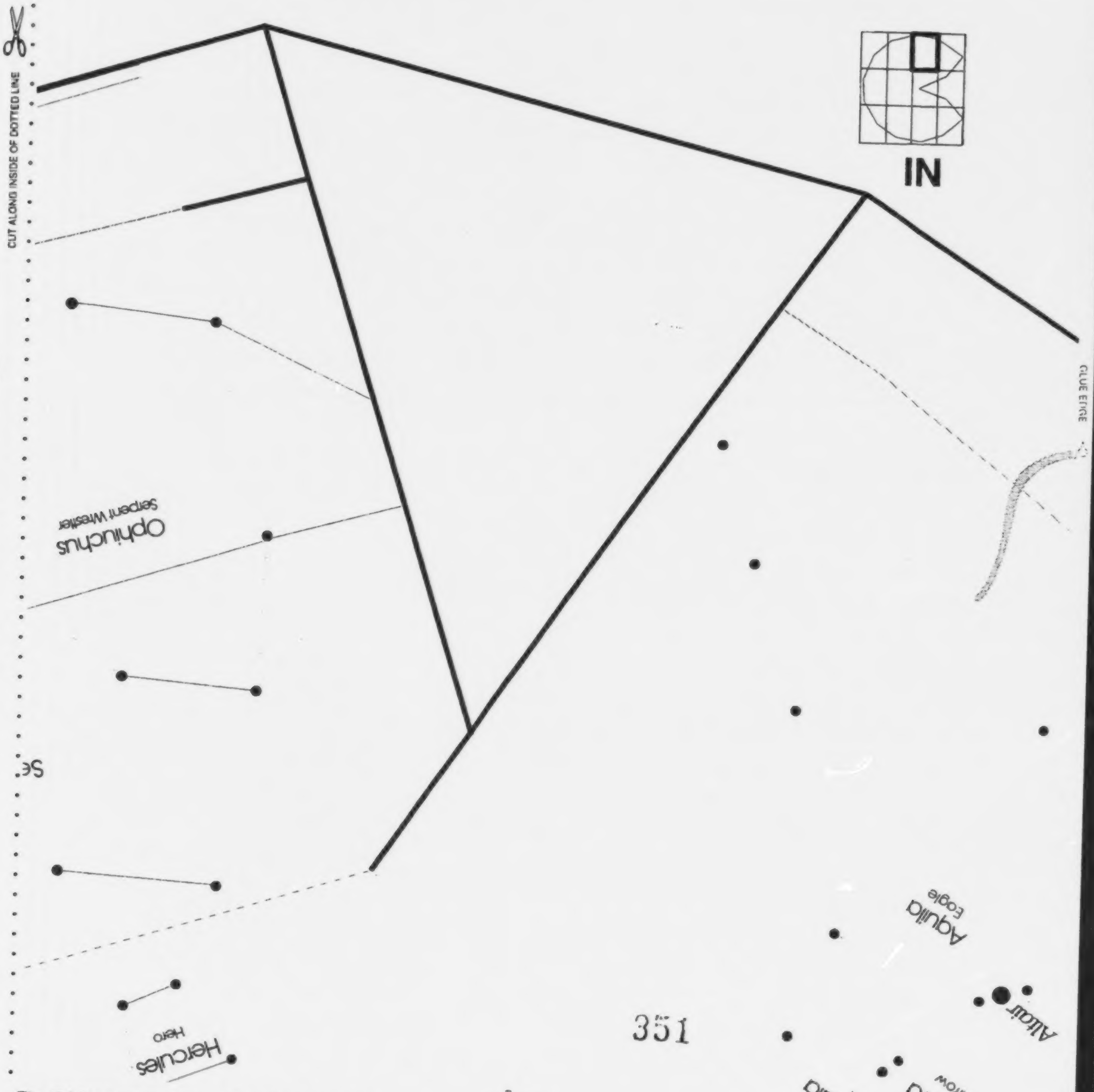
GLUE EDGE

CUT ALONG INSIDE OF DOTTED LINE



IN


Scorpius
Scorpion
Antares
Libra
Scales
Nov 20
Zubenelgenubi
Zubeneschamali
Oct 20
16 hr
Serpens Caput
Serpent's Head
Arcturus
Corona Borealis
Northern Crown
GLUE EDGE
GLUE EDGE


CUT ALONG INSIDE OF DOTTED LINE
IN
GLUE EDGE
Ophiuchus
Serpent Wrestler
Hercules
Hero
Aquila
Eagle
Altair
Sagitta
Arrow

351

GLUE EDGE

CUT ALONG INSIDE OF DOTTED LINE

DASH—IN

12 pages

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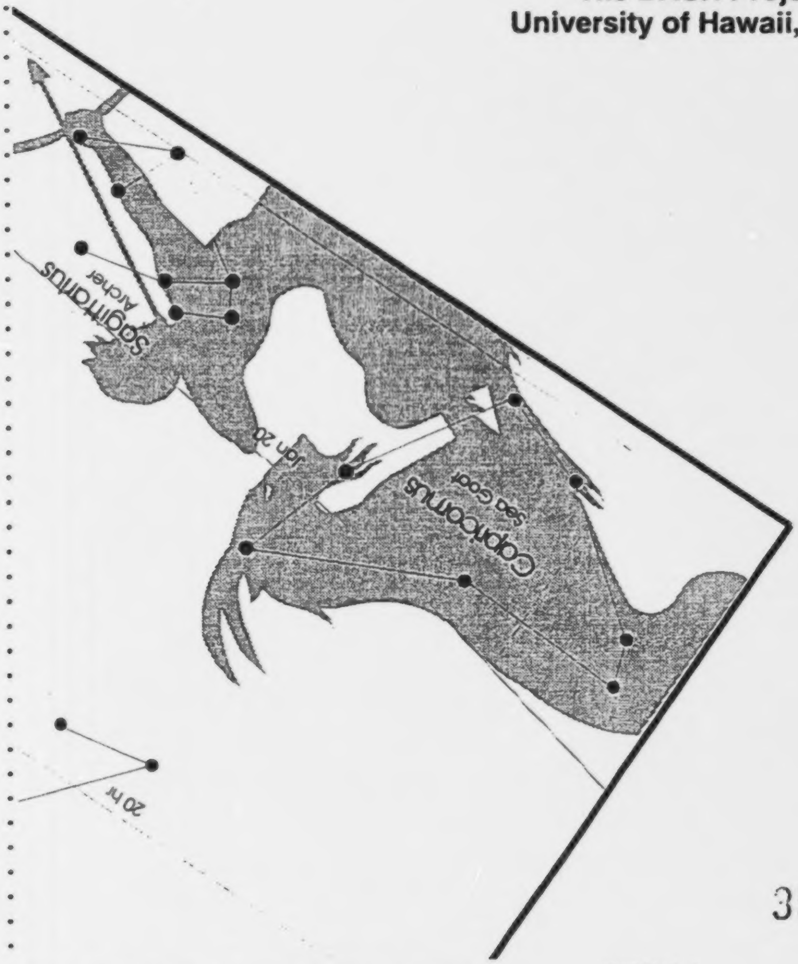
Sagittarius
Archer
Jan 20
Capricornus
Sea Goat
20 hr

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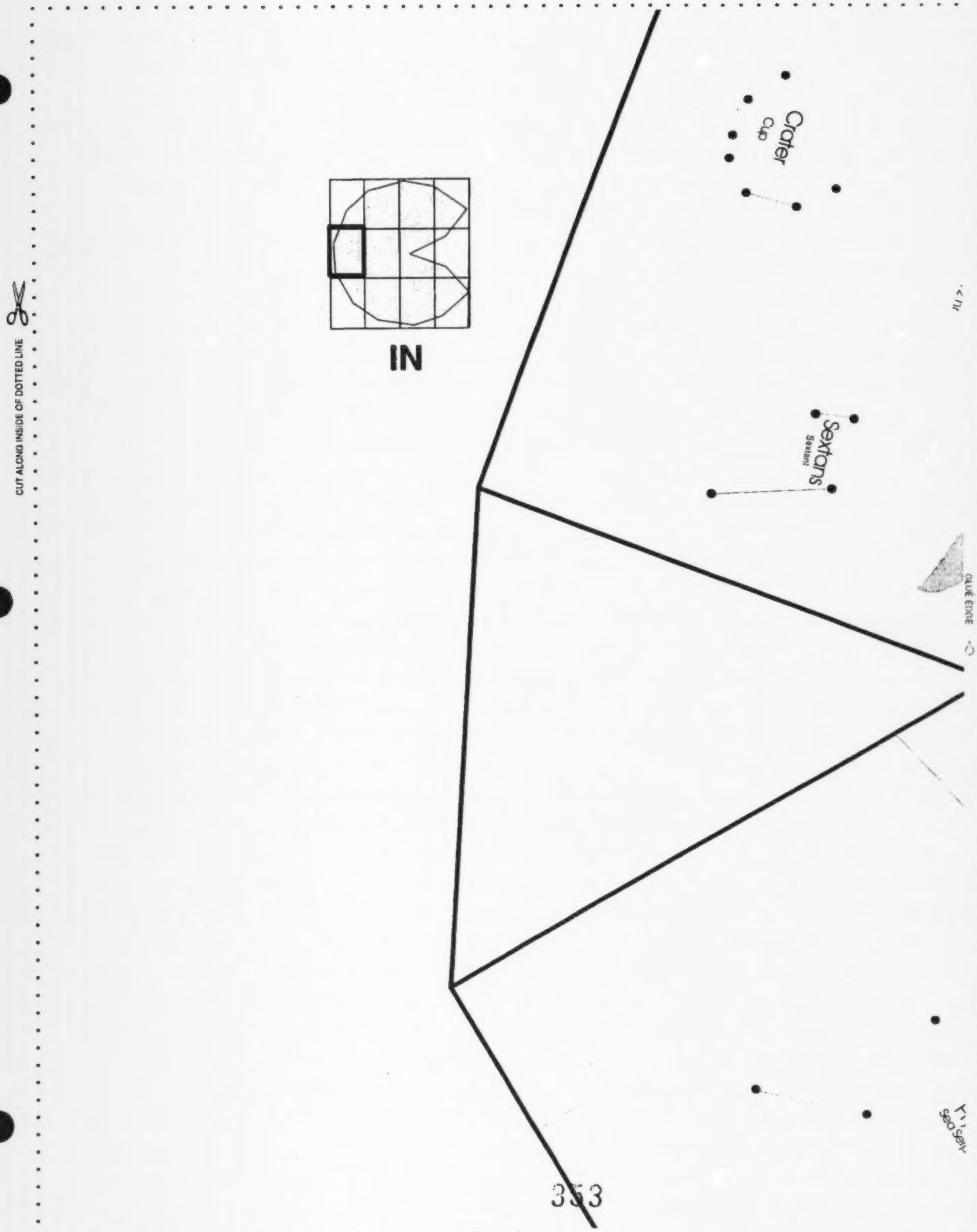
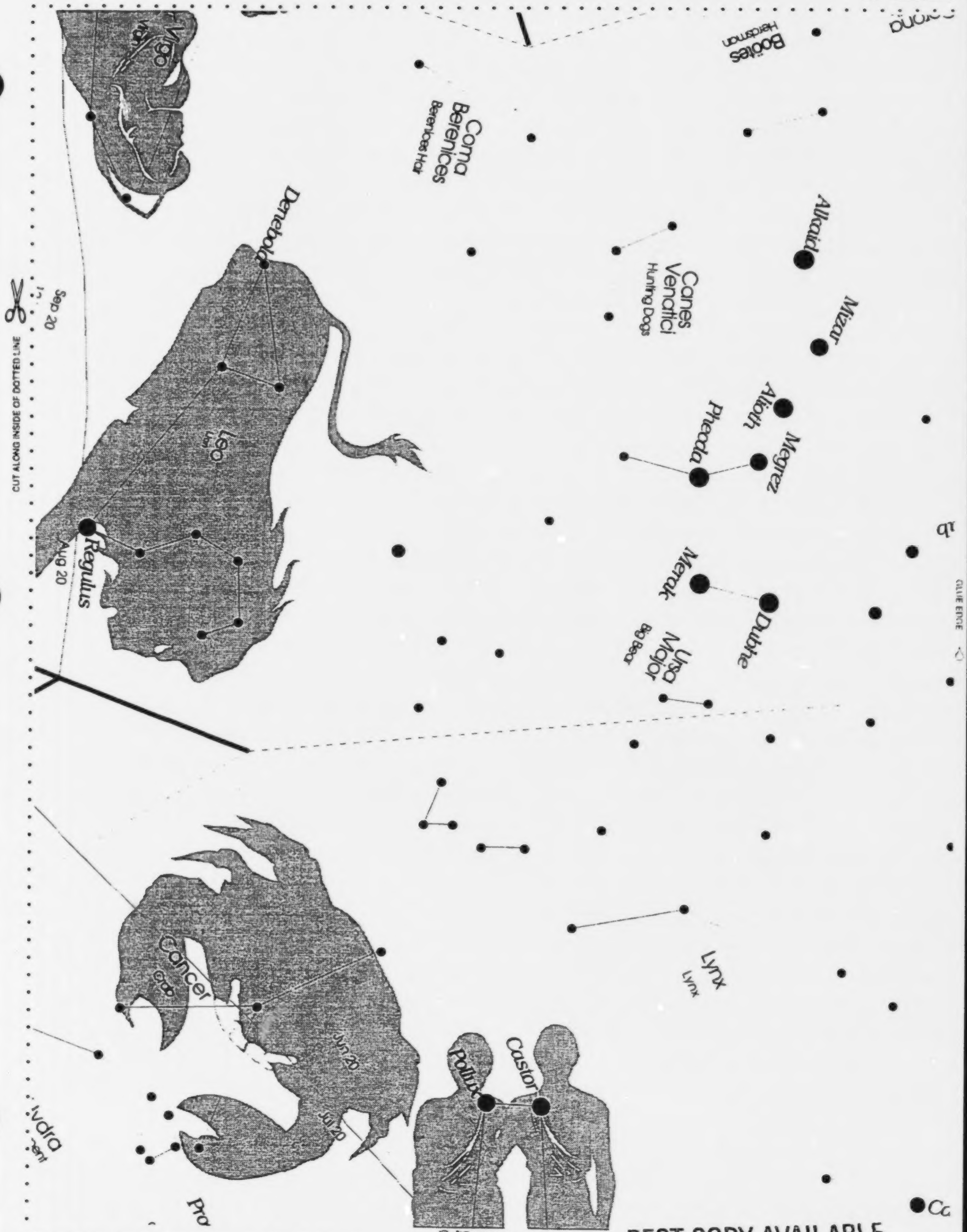
GLUE EDGE


CUT ALONG INSIDE OF DOTTED LINE
IN
Crater
Cup
Sextans
Sextant
GLUE EDGE 5
GLUE EDGE 6


Boötes
Herdsman
Virgo
Coma
Berenices
Berenices Hair
Denebola
Alkaid
Canes
Venatici
Hunting Dogs
Mizar
Alioth
Megrez
Phecda
Leo
Lion
Regulus
Aug 20
Sep 20
CUT ALONG INSIDE OF DOTTED LINE
GLUE EDGE
Merak
Dubhe
Ursa
Major
Big Bear
Lynx
Lynx
Cancer
Crab
Jun 20
Jul 20
Castor
Pollux
Hydra
Pro
Ca
GLUE EDGE

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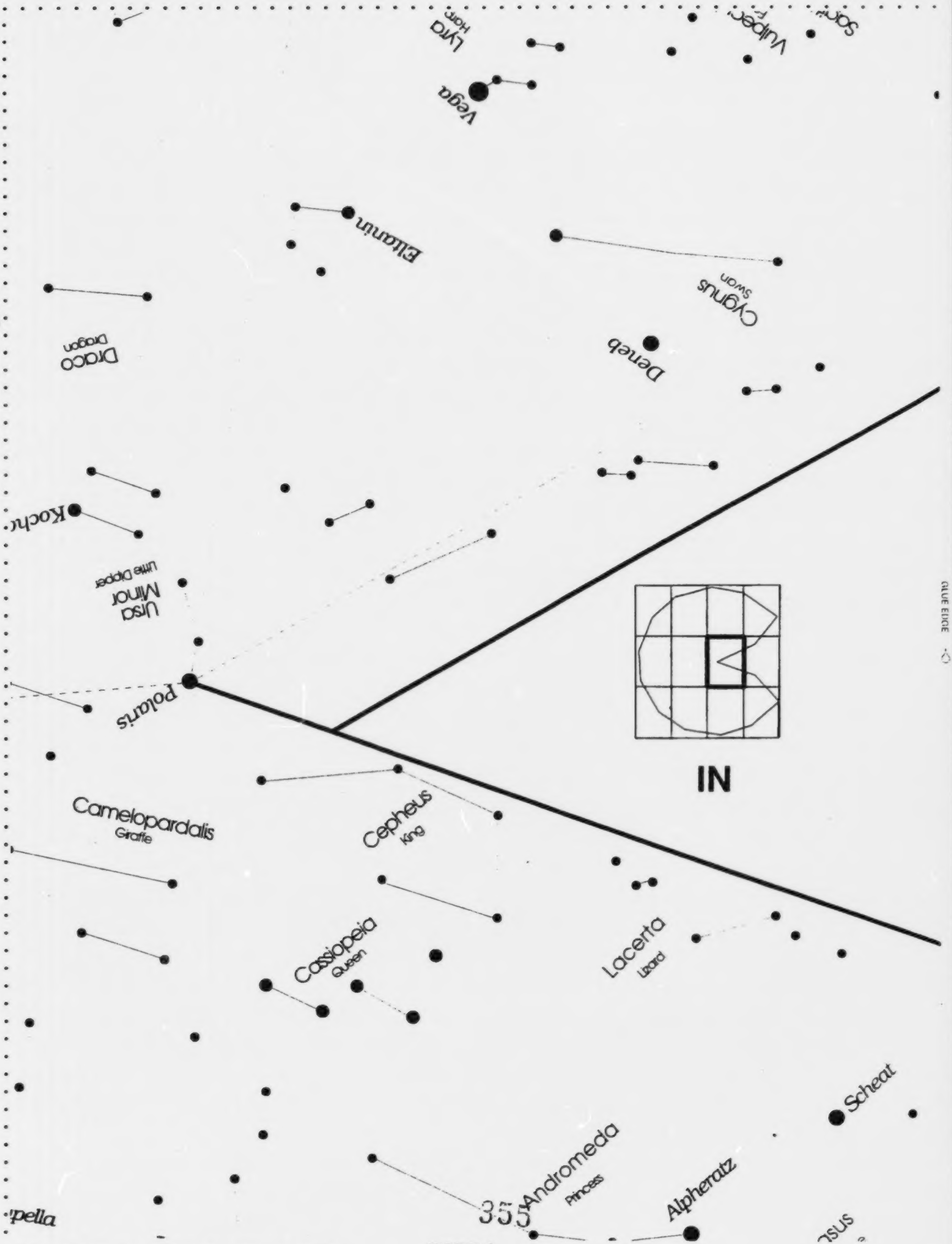
CUT ALONG INSIDE OF DOTTED LINE

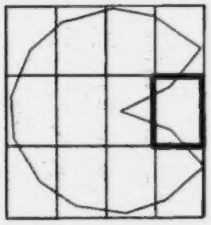

Lyra
Harp
Vulpec
Sag
Vega
Eltanin
Cygnus
Swan
Draco
Dragon
Deneb
Koch
Ursa
Minor
Little Dipper
Polaris
IN
Camelopardalis
Giraffe
Cepheus
King
Cassiopeia
Queen
Lacerta
Lizard
Scheat
Andromeda
Princess
Alpheratz
pella

GLUE EDGE

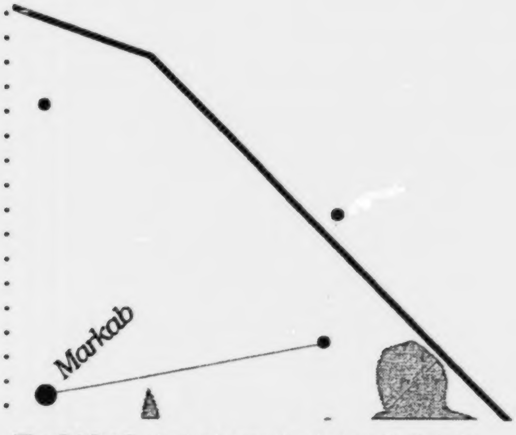
GLUE EDGE

Delphinus
Dolphin

CUT ALONG INSIDE OF DOTTED LINE

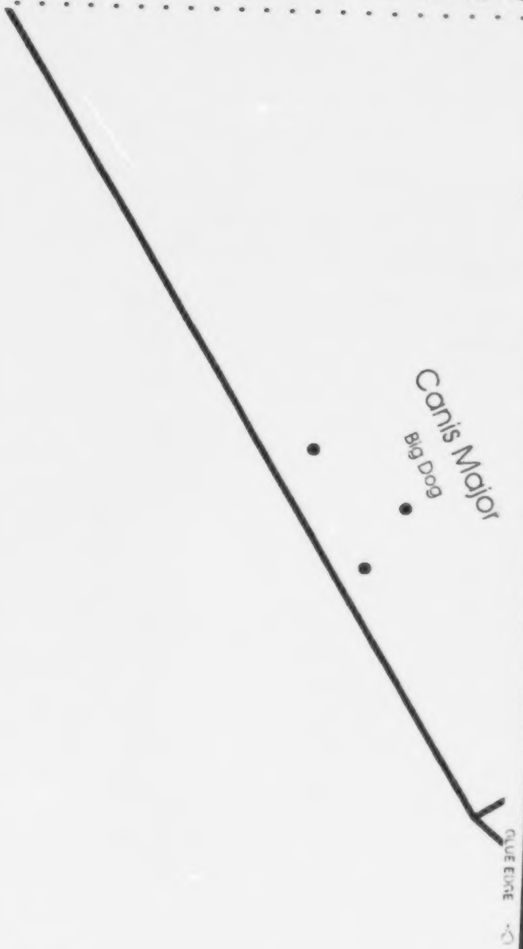


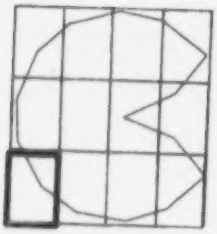
IN

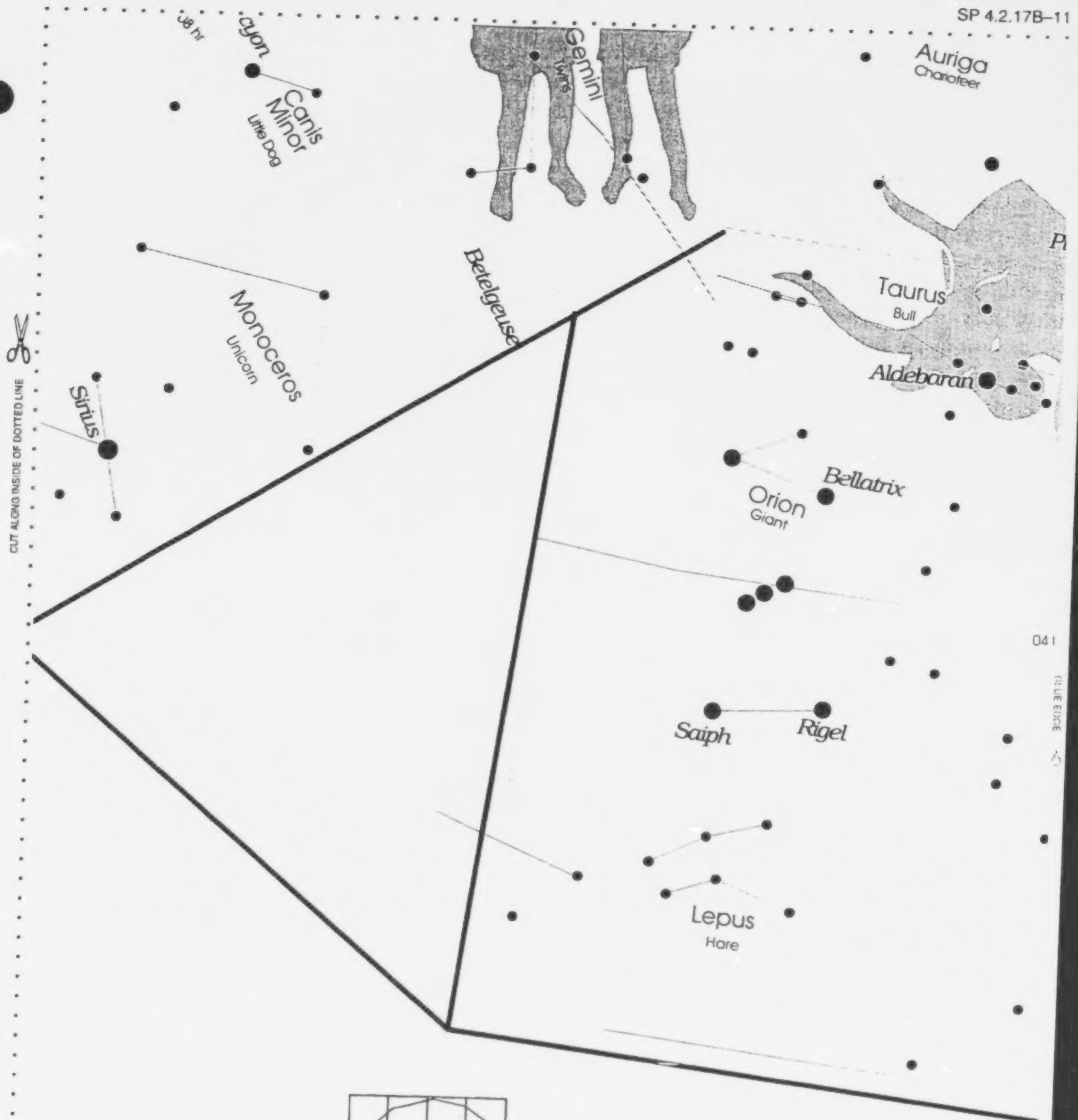


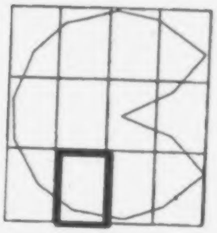
GLUE EDGE

CUT ALONG INSIDE OF DOTTED LINE


Canis Major
Big Dog
GLUE EDGE




cyon
Canis Minor
Little Dog
Gemini
Twins
Auriga
Charioteer
Betelgeuse
Monoceros
Unicorn
Sirius
Taurus
Bull
Aldebaran
Orion
Giant
Bellatrix
Saiph
Rigel
Lepus
Hare
CUT ALONG INSIDE OF DOTTED LINE



IN

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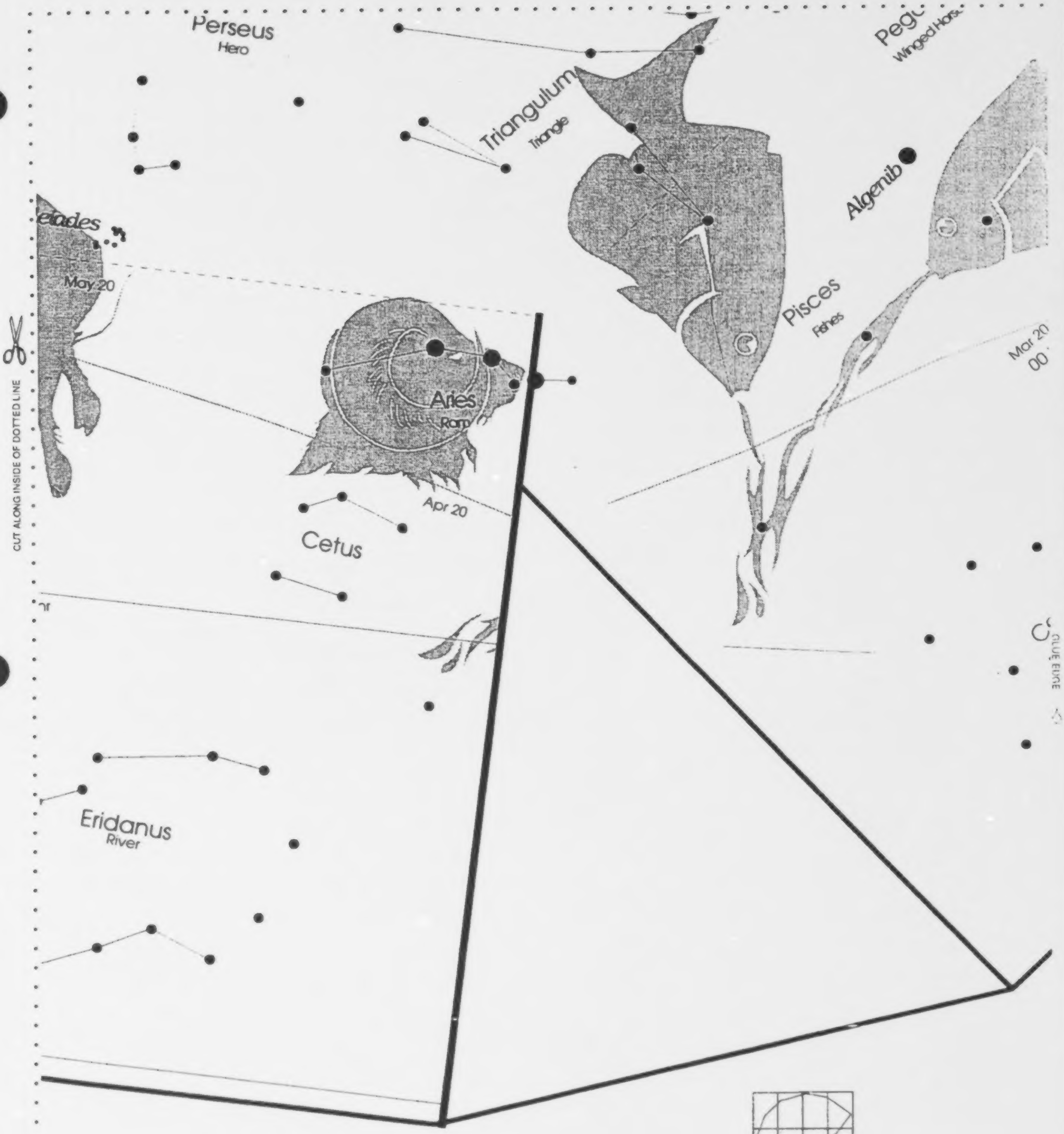
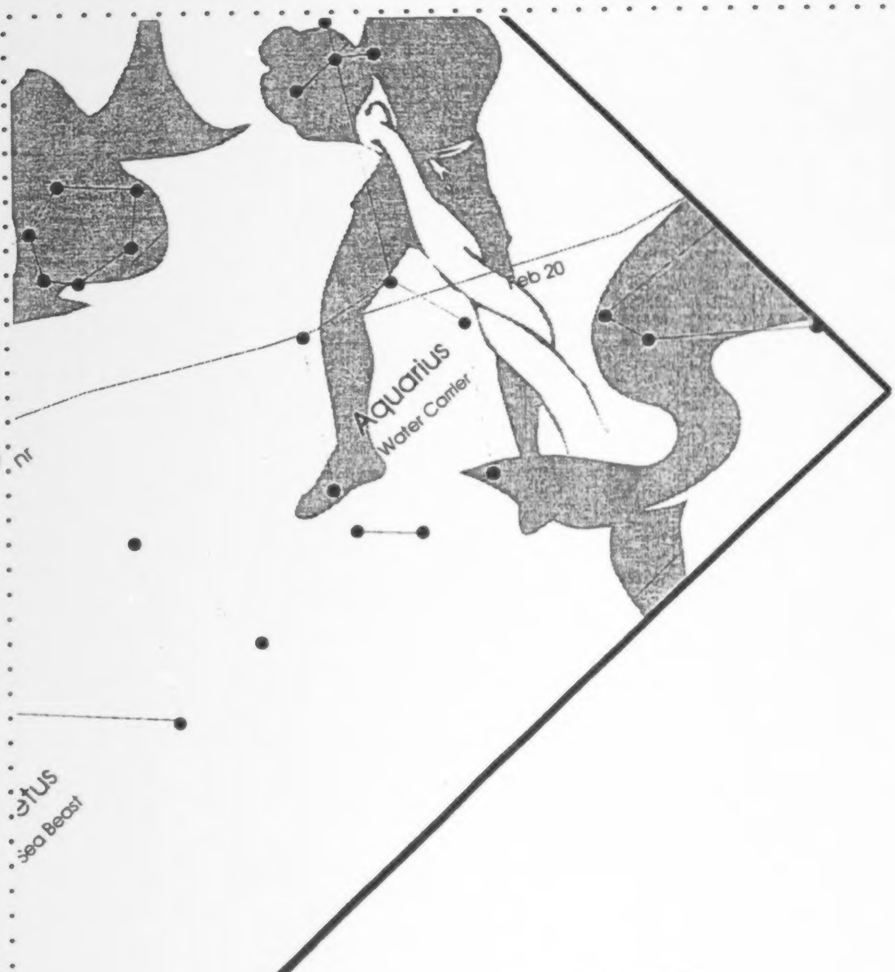
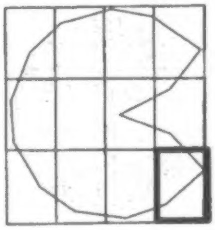

Perseus
Hero
Pegc
Winged Hors
Triangulum
Triangle
Algenib
eiades
May 20
Pisces
Fishes
Mar 20
00
Aries
Ram
Apr 20
Cetus
Eridanus
River
CUT ALONG INSIDE OF DOTTED LINE
GLUE EDGE

IN

BEST COPY AVAILABLE

CUT ALONG INSIDE OF DOTTED LINE


Feb 20
Aquarius
Water Carrier
nr
etus
Sea Beast



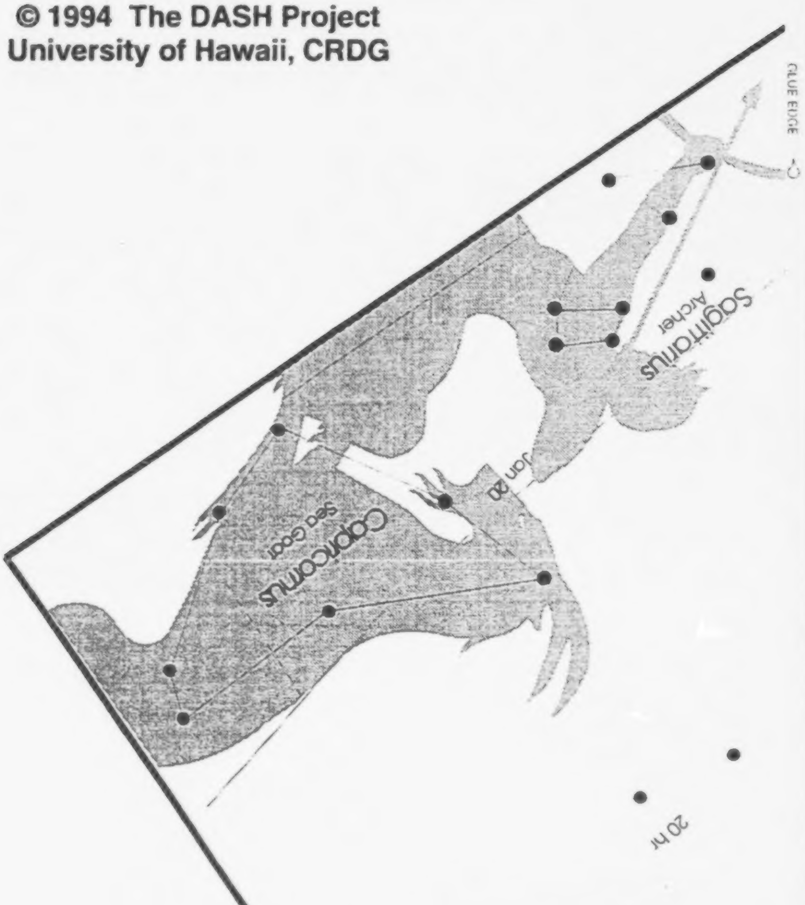
IN

CUT ALONG INSIDE OF DOTTED LINE

DASH—OUT

12 pages

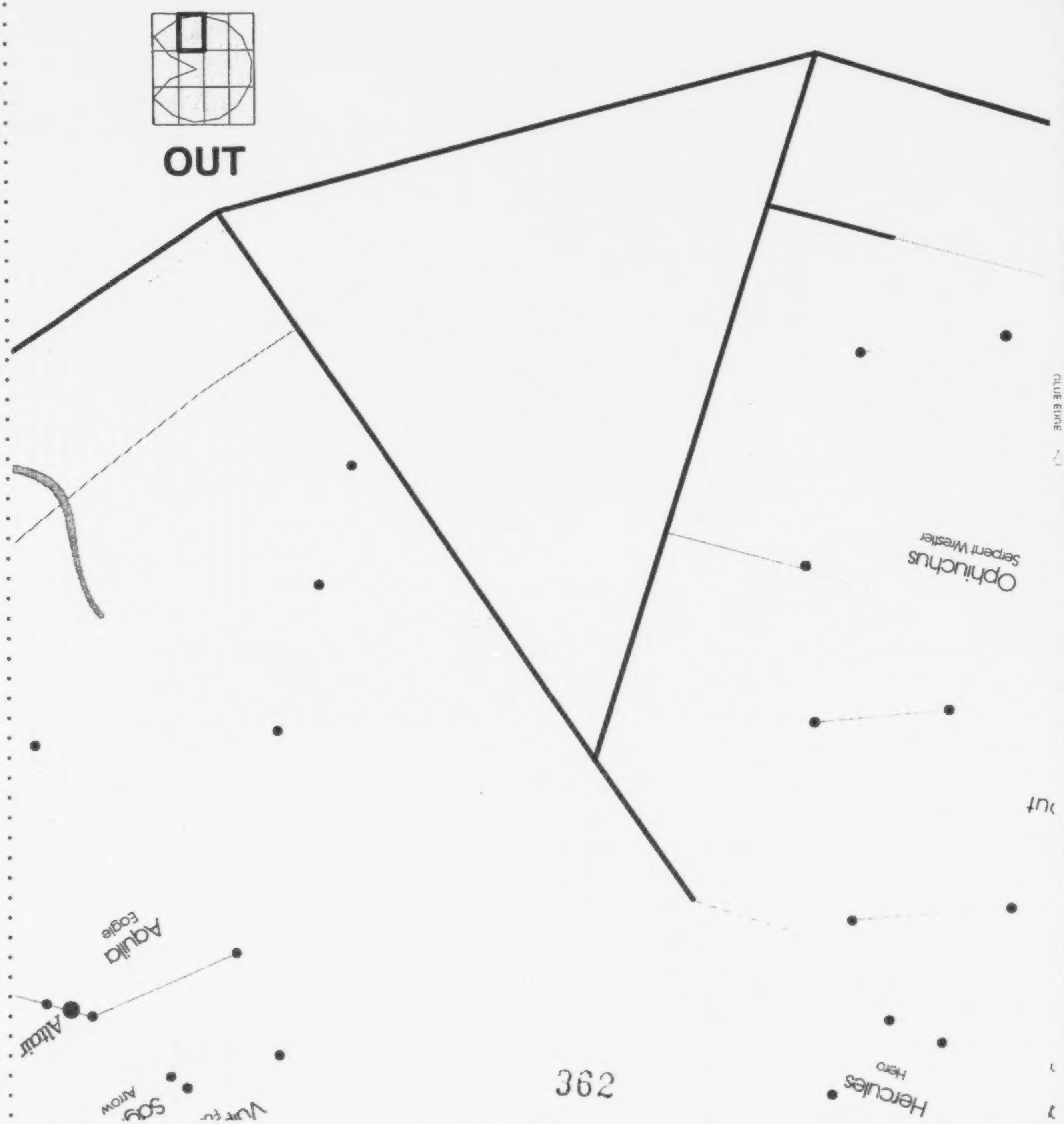
University of Hawaii, CRDG


GLUE EDGE
Sagittarius
Archer
Jan 20
Capricornus
Sea Goat
20 hr

BEST COPY AVAILABLE

GLUE EDGE

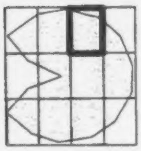
CUT ALONG INSIDE OF DOTTED LINE


OUT
Ophiuchus
Serpent Wrestler
Aquila
Eagle
Altair
Sagitta
Arrow
Hercules
Hero
GLUE EDGE

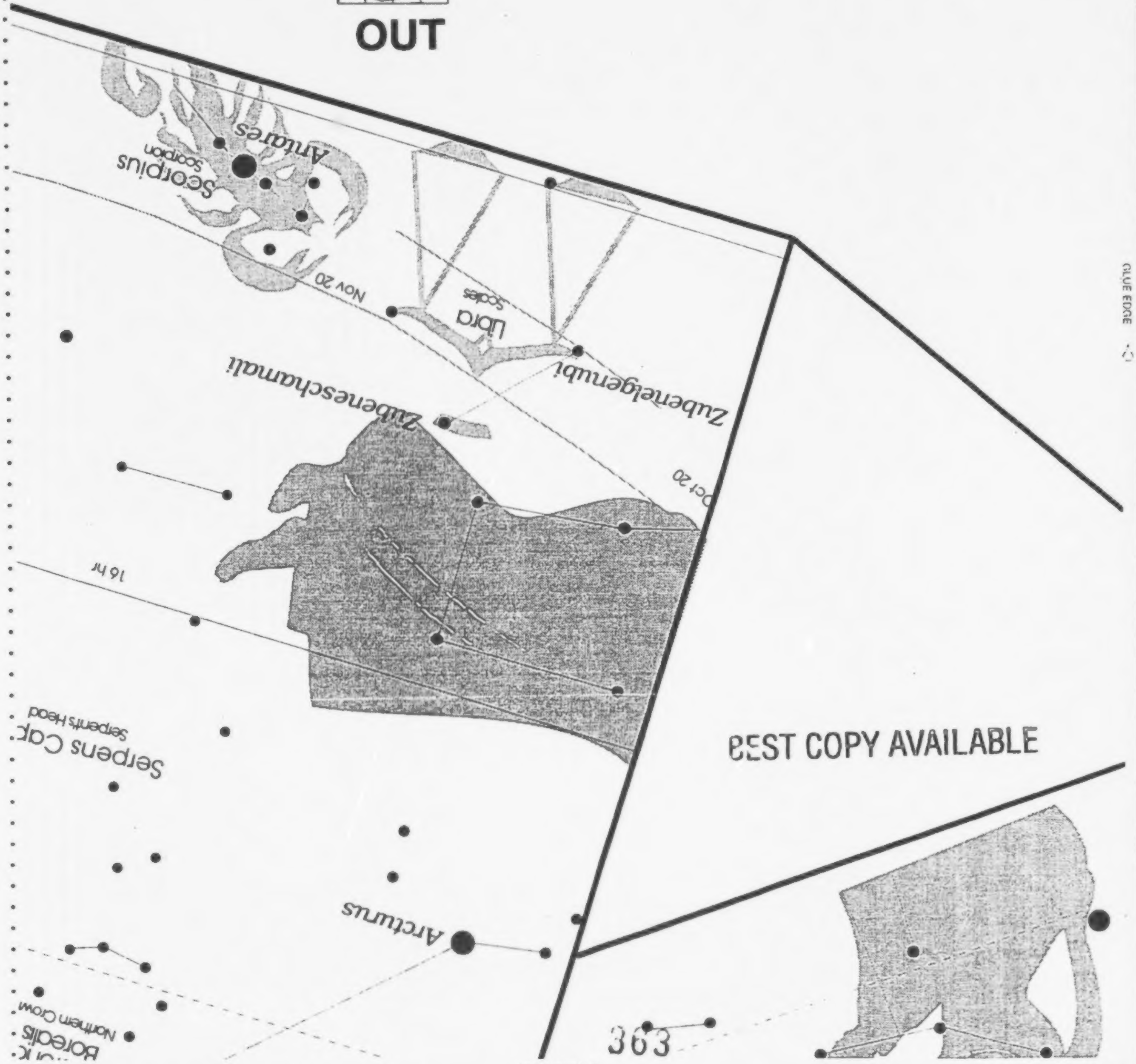
362

GLUE EDGE

CUT ALONG INSIDE OF DOTTED LINE



OUT


Scorpius
Scorpion
Antares
Libra
Scales
Nov 20
Zubenelgenubi
Zubeneschamali
Oct 20
16 hr
Serpens Cap
Serpent's Head
Arcturus
Northern Crow
Borealis

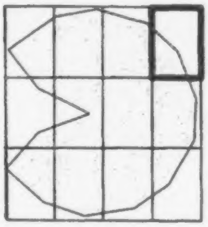
GLUE EDGE

BEST COPY AVAILABLE

GLUE EDGE

✂ CUT ALONG INSIDE OF DOTTED LINE

DASH—OUT



12 pages

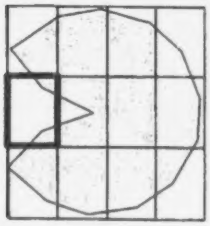
University of Hawaii, CRDG

Spica
Corvus
Crow

364

GLUE EDGE

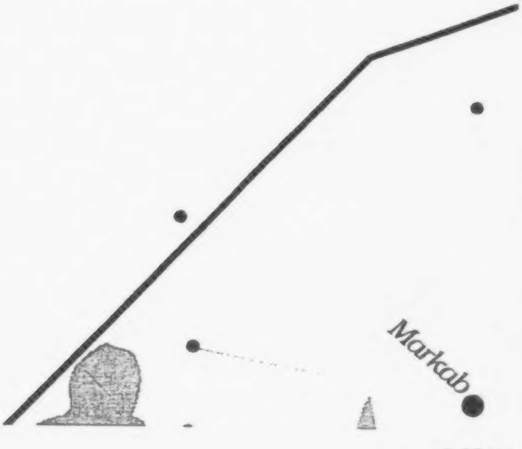
Delphinus
Dolphin



OUT

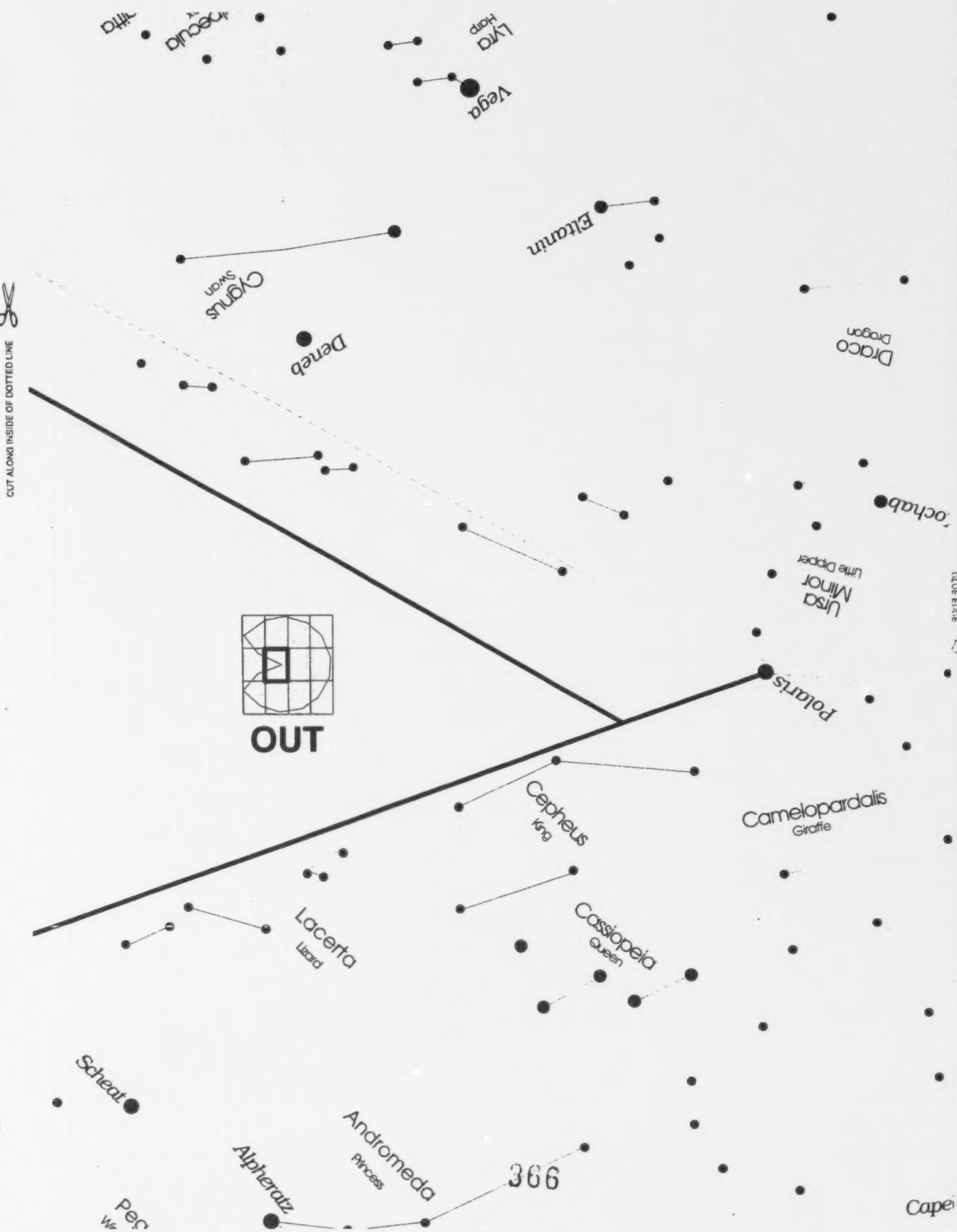
CUT ALONG INSIDE OF DOTTED LINE

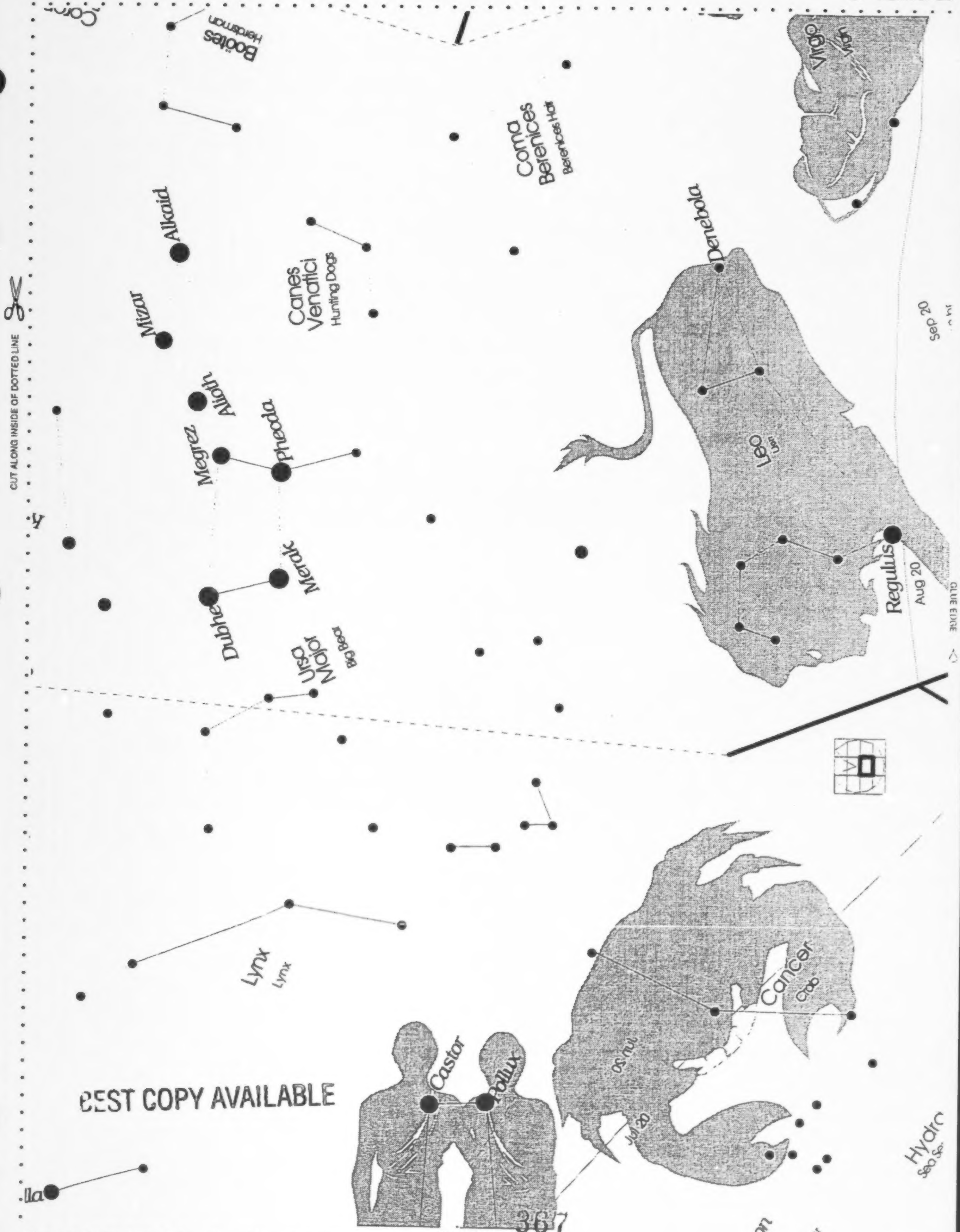
GLUE EDGE



365

GLUE EDGE


itta
ecula
Lyra
Harp
Vega
Eltanin
Cygnus
Swan
Deneb
Draco
Dragon
ochab
Ursa
Minor
Little Dipper
Polaris
CUT ALONG INSIDE OF DOTTED LINE
OUT
GLUE EDGE
Cepheus
King
Camelopardalis
Giraffe
Lacerta
Lizard
Cassiopeia
Queen
Scheat
Andromeda
Princess
Alpheratz
Peg
W
Cape
GLUE EDGE

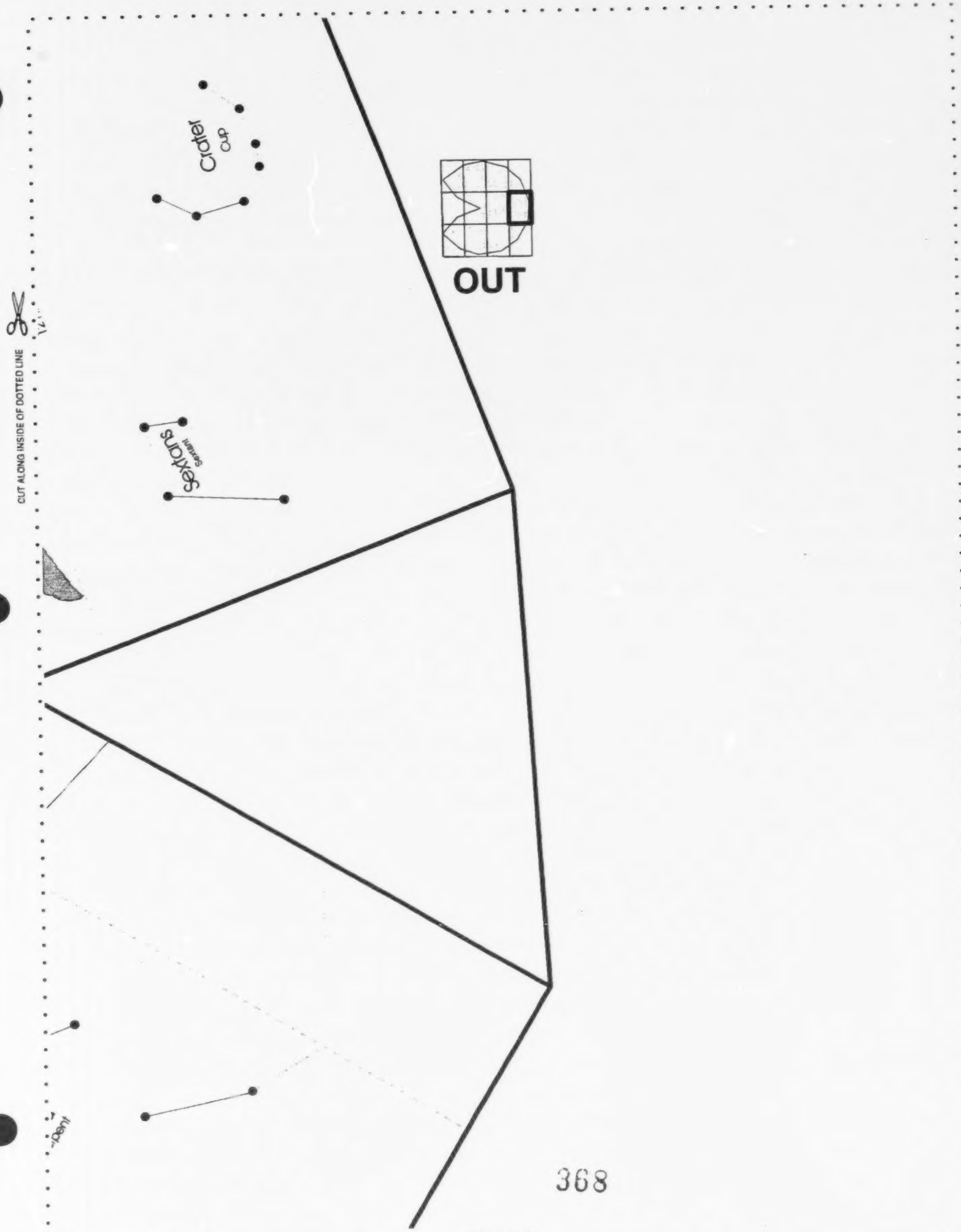

Boötes
Herdsman
Alkaid
Mizar
Alioth
Megrez
Phecda
Dubhe
Merak
Ursa Major
Big Bear
Canes Venatici
Hunting Dogs
Coma Berenices
Berenices Hair
Virgo
Virgin
Denebola
Leo
Lion
Regulus
Aug 20
Sep 20
Lynx
Lynx
Cancer
Crab
Jul 20
Jun 20
Castor
Pollux
Hydra
Sea Se
lla

CUT ALONG INSIDE OF DOTTED LINE

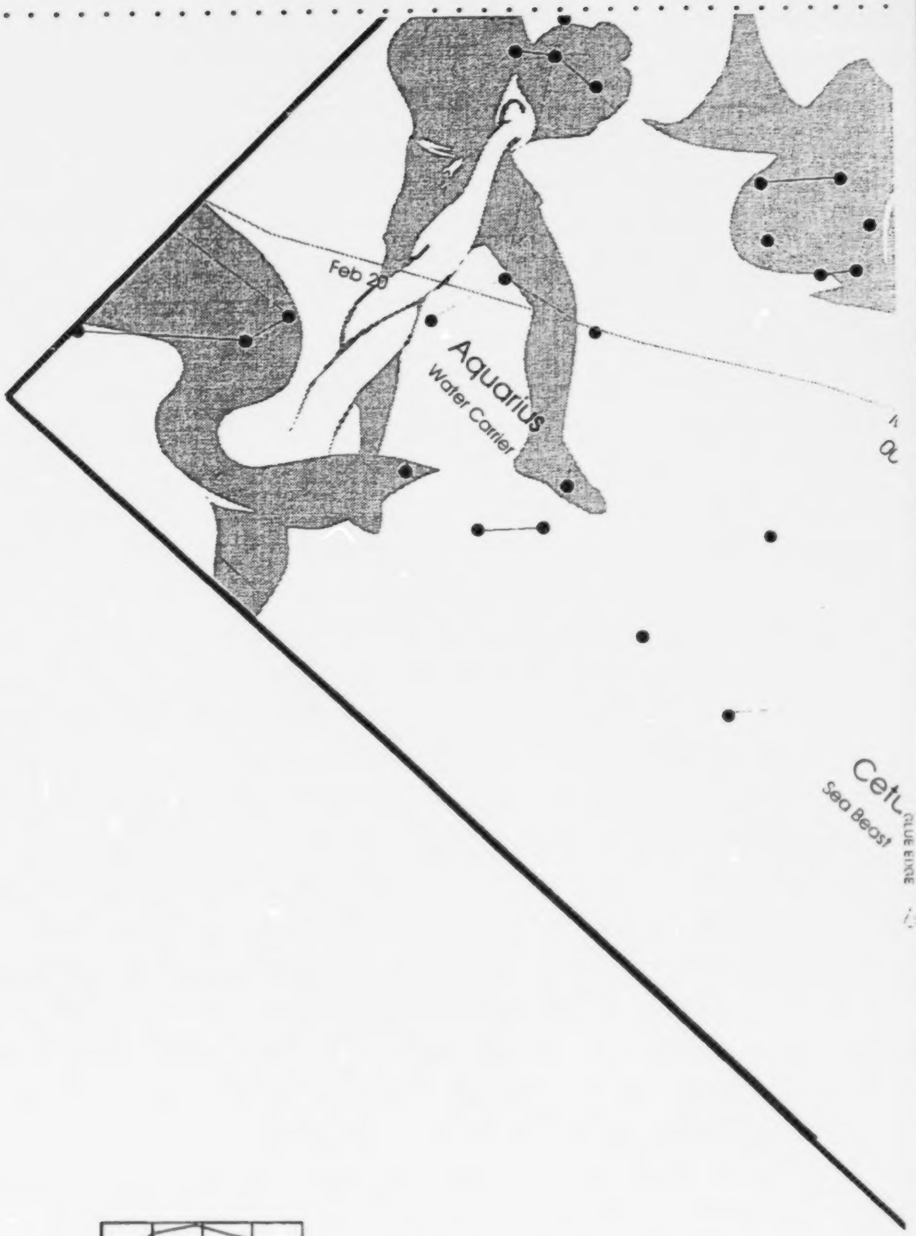
GLUE EDGE

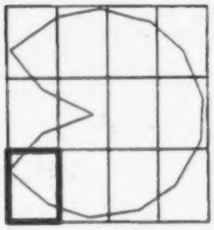
GLUE EDGE

BEST COPY AVAILABLE


CUT ALONG INSIDE OF DOTTED LINE
Crater
Cup
OUT
Sextans
Sextant
GLUE EDGE

CUT ALONG INSIDE OF DOTTED LINE


Feb 20
Aquarius
Water Carrier
Cet
Sea Beast
GLUE EDGE



OUT

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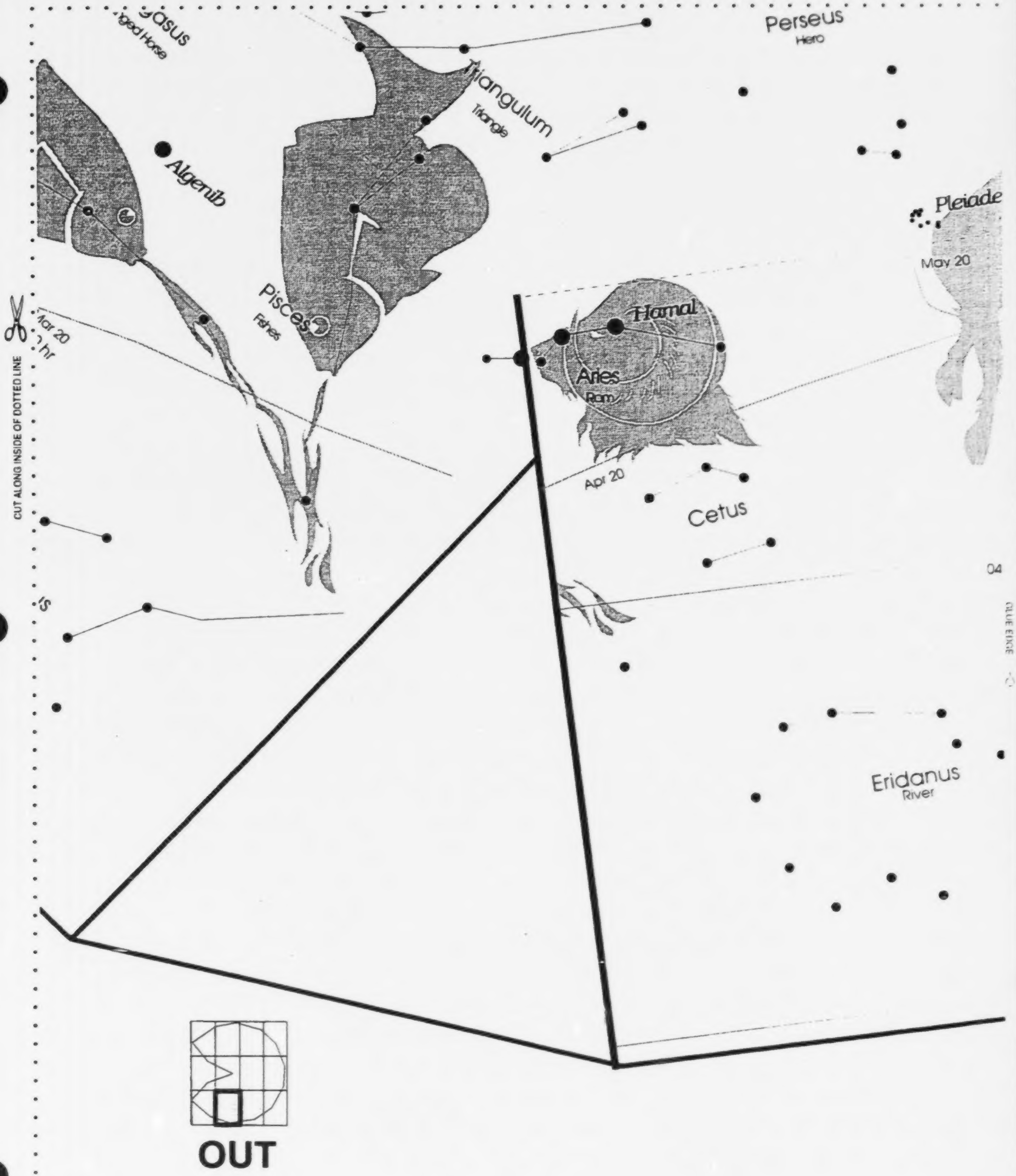
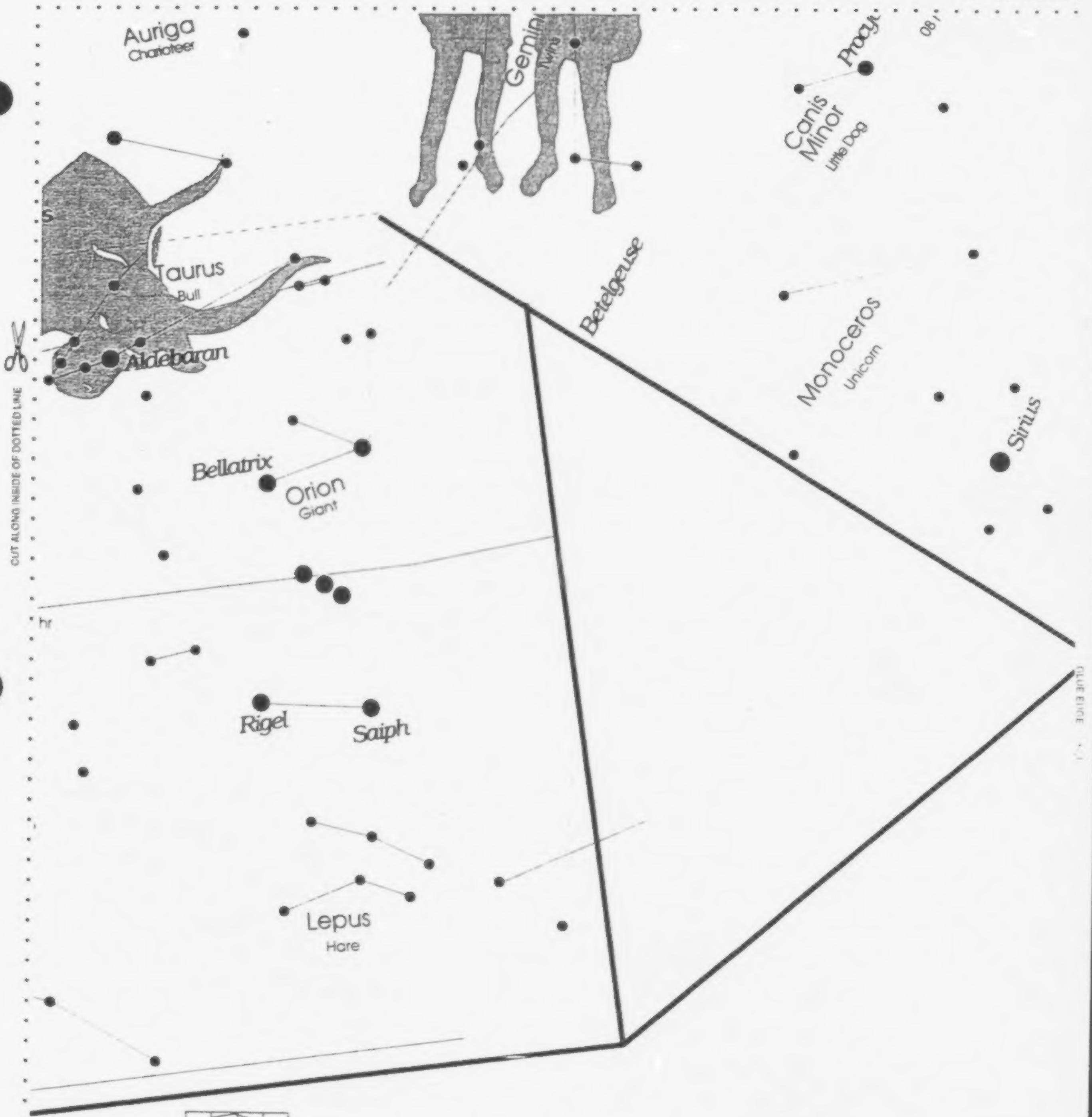
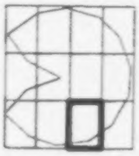
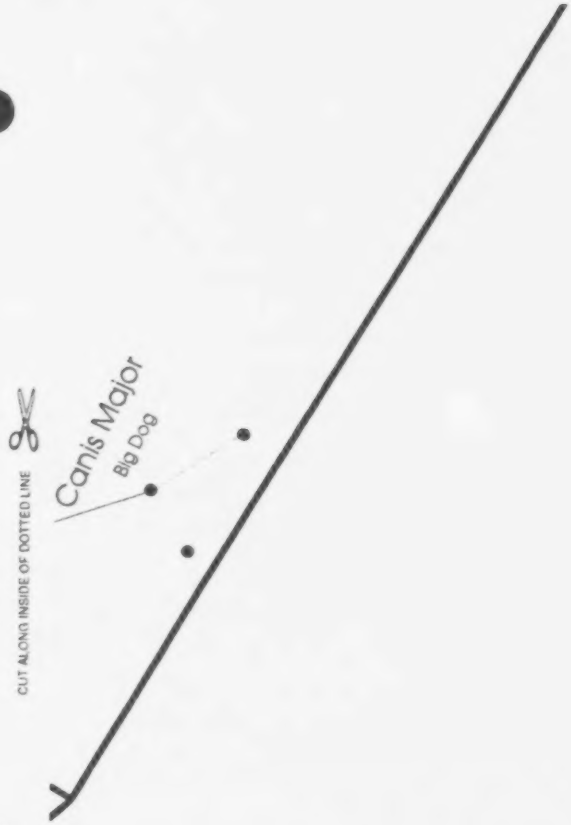

gasus
ged Horse
Perseus
Hero
Triangulum
Triangle
Algenib
Pleiade
May 20
Pisces
Fishes
Hamal
Aries
Ram
Mar 20
hr
Apr 20
Cetus
04
GLUE EDGE
Eridanus
River
CUT ALONG INSIDE OF DOTTED LINE
OUT

BEST COPY AVAILABLE


CUT ALONG INSIDE OF DOTTED LINE
Auriga
Charioteer
Gemini
Twins
Procy
Canis Minor
Little Dog
Taurus
Bull
Aldebaran
Betelgeuse
Monoceros
Unicorn
Sirius
Bellatrix
Orion
Giant
hr
Rigel
Saiph
Lepus
Hare
GLUE EDGE



OUT


CUT ALONG INSIDE OF DOTTED LINE
Canis Major
Big Dog

OUT

Name________________________

Date________________________

DASH

STUDENT PAGE 4.2.18 USING THE PLANETARIUM

1. Describe how you found the North Star.

2. Draw the stars in the constellation of the zodiac you expect to find nearest the western horizon after sunset. Connect the constellation's stars with lines as they are shown on the planetarium. Use an (X) to mark the ones you can find.

OCTOBER

NOVEMBER

DECEMBER

JANUARY

FEBRUARY

MARCH

APRIL

MAY

Name________________________

Date_________________________

DASH

STUDENT PAGE 4.2.19A THE PLANETS

1. How is a planet like a star?

2. How is a planet different from a star?

3. Where do we find planets in the sky?

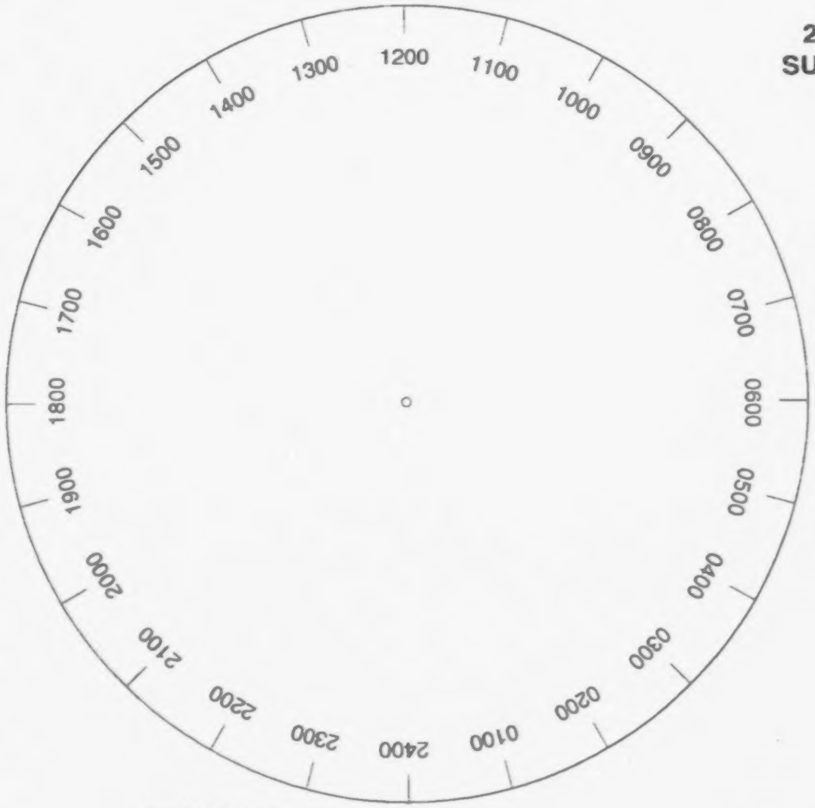
4. What is the next brightest object in the sky after the sun and the moon.

5. How may planets does the sun have? What are they?

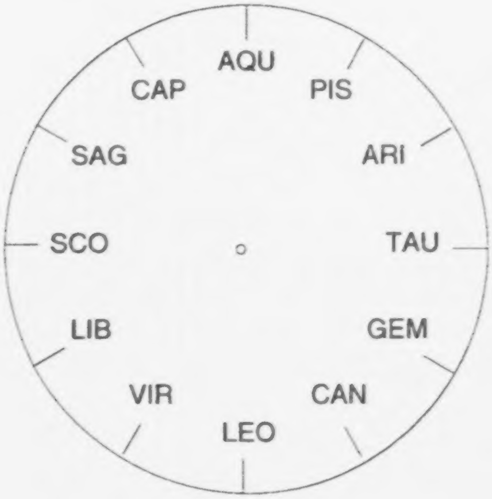
DASH	SP 4.2.19B PLANET FINDER	Name ____________ Date ____________

Cut out and assemble the items below to make a planet finder.

24-HOUR SUN CLOCK


1200
1100
1000
0900
0800
0700
0600
0500
0400
0300
0200
0100
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300

ZODIACAL CONSTELLATION CIRCLE


AQU
PIS
ARI
TAU
GEM
CAN
LEO
VIR
LIB
SCO
SAG
CAP

SUN POINTER

PLANET POINTER

Figure SP 4.2.19B Planet finder

Name________________________

Date________________________

DASH

STUDENT PAGE 4.2.19C THE SUN'S ZODIACAL MOVEMENT

CONSTELLATION NAMES IN ZODIACAL ORDER	*DATES SUN IS IN THE ZODIACAL CONSTELLATION
Capricornus, the Goat	January 19–February 15
Aquarius, the Water Bearer	February 16–March 11
Pisces, the Fishes	March 12–April 18
Aries, the Ram	April 19–May 13
Taurus, the Bull	May 14–June 20
Gemini, the Twins	June 21—July 19
Cancer, the Crab	July 20–August 9
Leo, the Lion	August 10–September 15
Virgo, the Virgin	September 16–October 30
Libra, the Balance	October 31–November 22
Scorpius, the Scorpion	November 23–December 17
Sagittarius, the Archer	December 18–January 18

*Adjust for Leap Years

STUDENT PAGE 4.2.19D
PLANETS AND THE CONSTELLATIONS

Name______________________

Date______________________

Locate the constellation a particular planet is in by checking or shading in the box under the name of the constellation.

ZODIACAL LOCATION OF ____________ EACH MONTH IN 199__

Months	Constellations of the Zodiac											
	CAP	AQU	PIS	ARI	TAU	GEM	CAN	LEO	VIR	LIB	SCO	SAG
JAN.												
FEB.												
MAR.												
APR.												
MAY												
JUNE												
JULY												
AUG.												
SEPT.												
OCT.												
NOV.												
DEC.												

Name________________________

Date________________________

DASH

STUDENT PAGE 4.2.20 WHEN IS IT NOON?

1. When is the shadow of the sun the shortest?

2. Record your working definition for solar noon.

3. What is the magnetic declination at your school? Describe how you found it?

Name________________________

Date________________________

STUDENT PAGE 4.2.21 MAKING A SUNDIAL

1. Explain why the shadow from a gnomon makes a poor sundial.

2. Describe how you found the altitude angle of the North Star.

3. Describe how you made your sundial.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.2.22A USING A SUNDIAL

1. Describe how you aligned your sundial so that the post was on a north-south line.

2. Describe how you marked your sundial to read in hours.

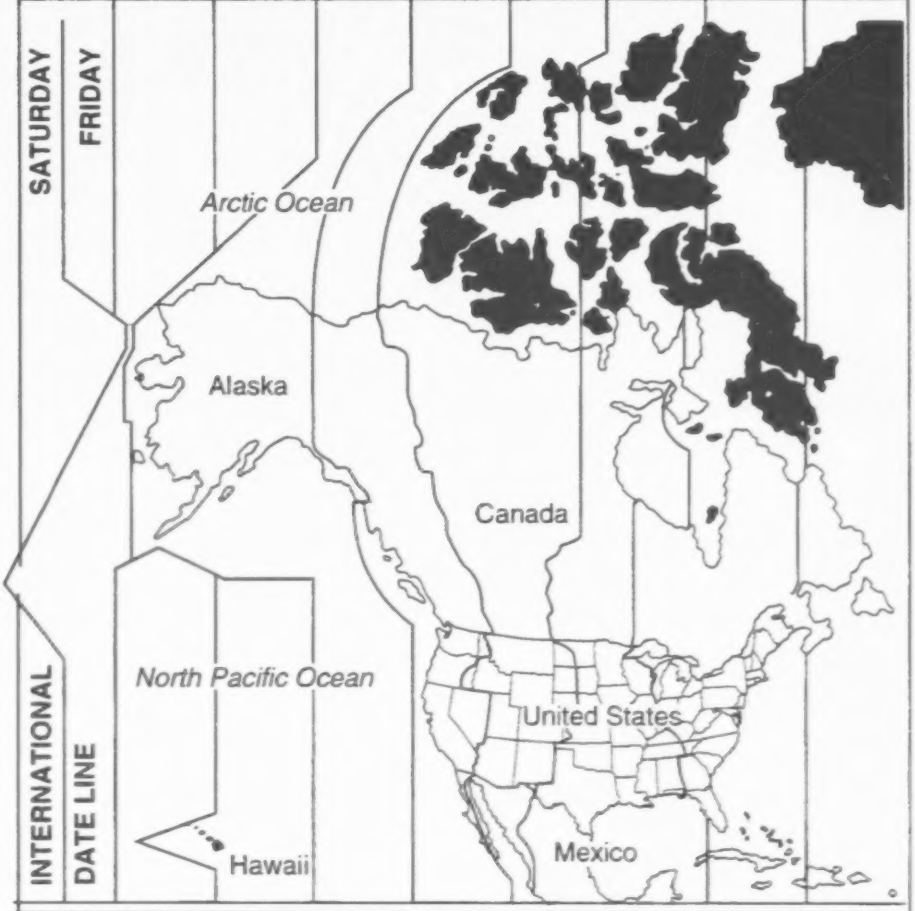
DASH

SP 4.2.22B TIME ZONES

Name ____________________

Date ____________________

Fill in the shaded blocks with the correct time for the standard time zone.


SATURDAY
FRIDAY
Arctic Ocean
Alaska
Canada
North Pacific Ocean
United States
Mexico
Hawaii
INTERNATIONAL
DATE LINE

2400	0100	0200	0300	0400	0500	0600	0700	0800
0100	0200	0300	0400					
0200		0400						
0300			0600		0800			
0400								
0500								
0600								
0700								
0800								
0900								
1000								
1100								

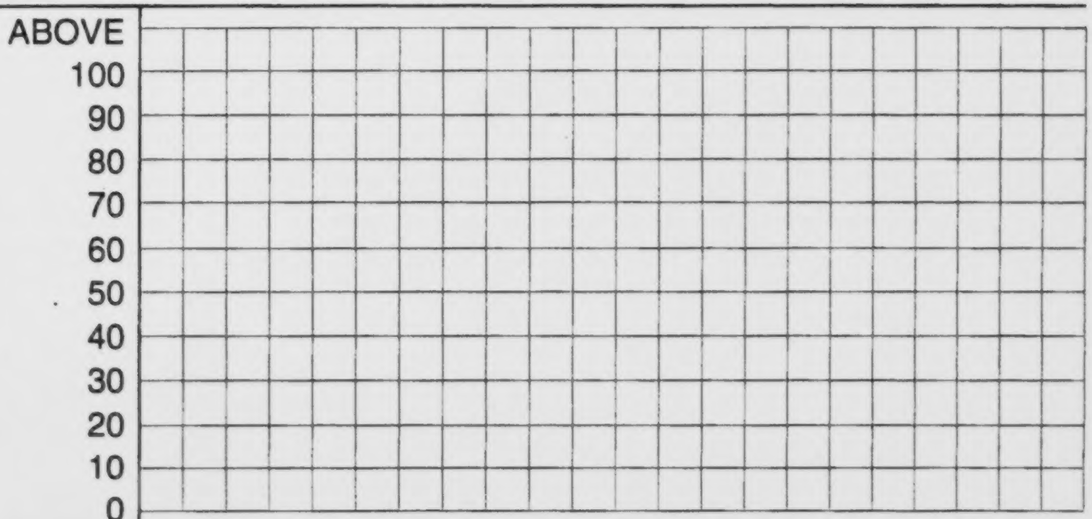
Figure SP 4.2.22B Time zones

SP 4.2.23 SEASONAL DATA

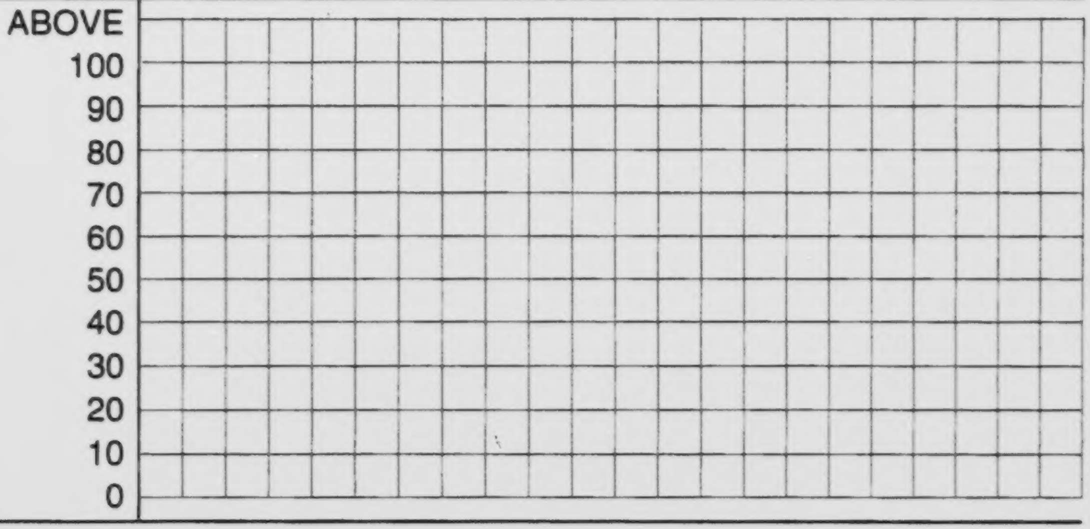
TEAM:

			1	2	3	4	5	6	7	8	9	10	11
	Midnight	2400											
		2100											
DAYLIGHT (Hr) LINE GRAPH		1800											
		1500											
		1200											
		0900											
		0600											
		0300											
	Midnight	2400											
CLOUD COVER (%) BAR GRAPH		100											
		50											
		0											
		30											
		25											
DAILY RAINFALL (cm or in) BAR GRAPH		20											
		15											
		10											
		5											
		0											

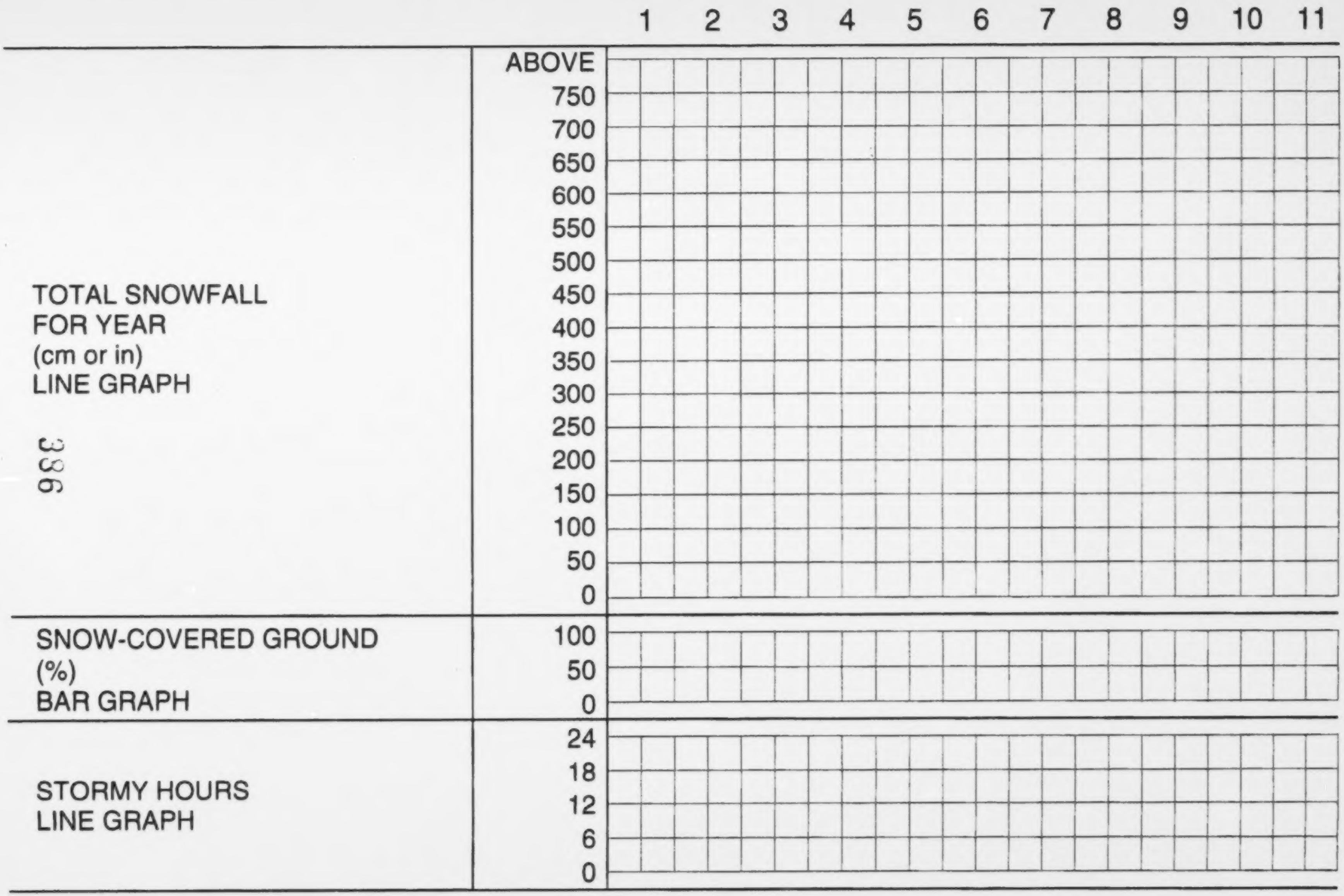
TOTAL RAINFALL
FOR YEAR
(cm or in)
LINE GRAPH



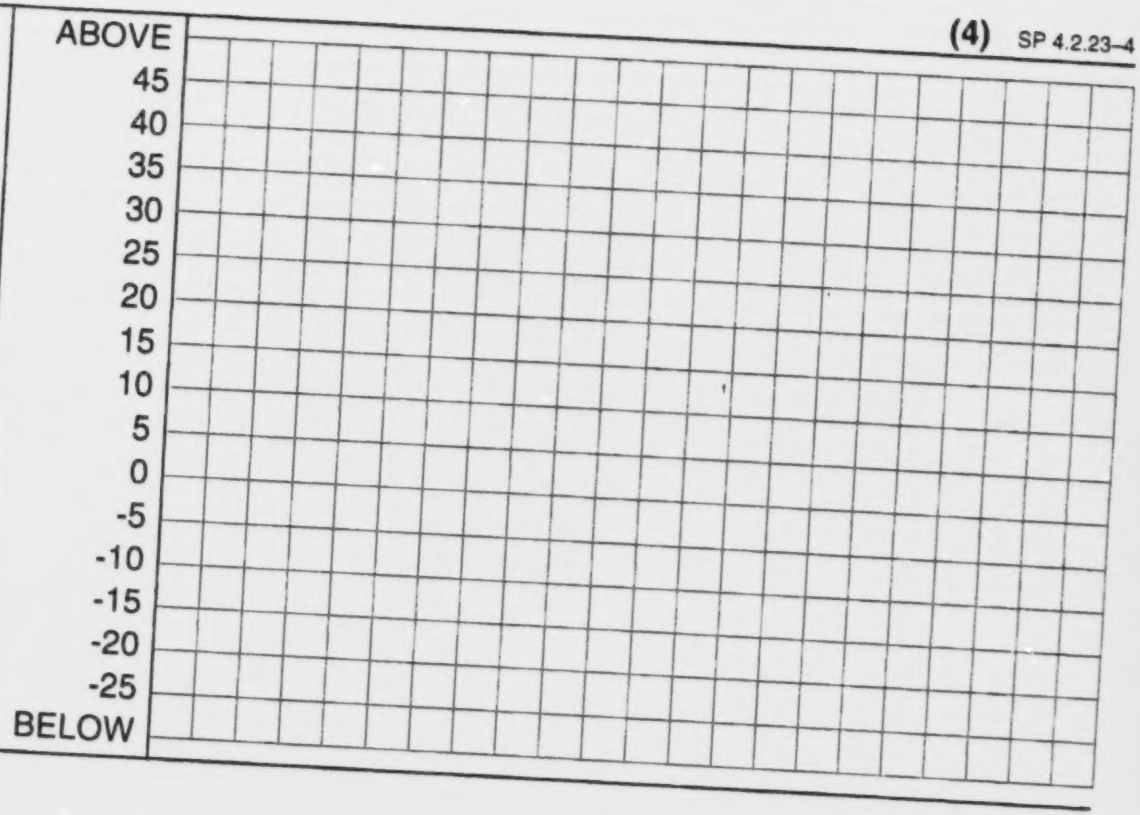
DAILY SNOWFALL
(cm or in)
BAR GRAPH



TEAM:


1
2
3
4
5
6
7
8
9
10
11
TOTAL SNOWFALL
FOR YEAR
(cm or in)
LINE GRAPH
ABOVE
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
SNOW-COVERED GROUND
(%)
BAR GRAPH
100
50
0
STORMY HOURS
LINE GRAPH
24
18
12
6
0

TEMPERATURE
(°C)
LINE GRAPH



TEAM:

(5) SP 4.2.23–5

	1	2	3	4	5	6	7	8	9	10	11
SCHOOL VACATION DAYS (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
NEW MOON (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
FIRST QUARTER MOON (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
FULL MOON (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
SECOND QUARTER MOON (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
SOLAR ECLIPSES (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
LUNAR ECLIPSES (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
HIGHEST TIDE (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
LOWEST TIDE (CHECK)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
OBSERVATIONS	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

The DASH Project, University of Hawaii, CRDG

(7) SP 4.2.23–7

Name ______________________________

Date ______________________________

MONTH: YEAR:

DAYS OF THE MONTH

12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31	

MONTH: YEAR: **(9)** SP 4.2.23–9

DAYS OF THE MONTH

12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

MONTH:

YEAR:

(11) SP 4.2.23–11

DAYS OF THE MONTH

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

DASH

Name___________________________

Date___________________________

STUDENT PAGE 4.2.24A PARTS OF A MOON-PHASE CLOCK

Cut out and assemble the parts to make a Moon-Phase Clock.

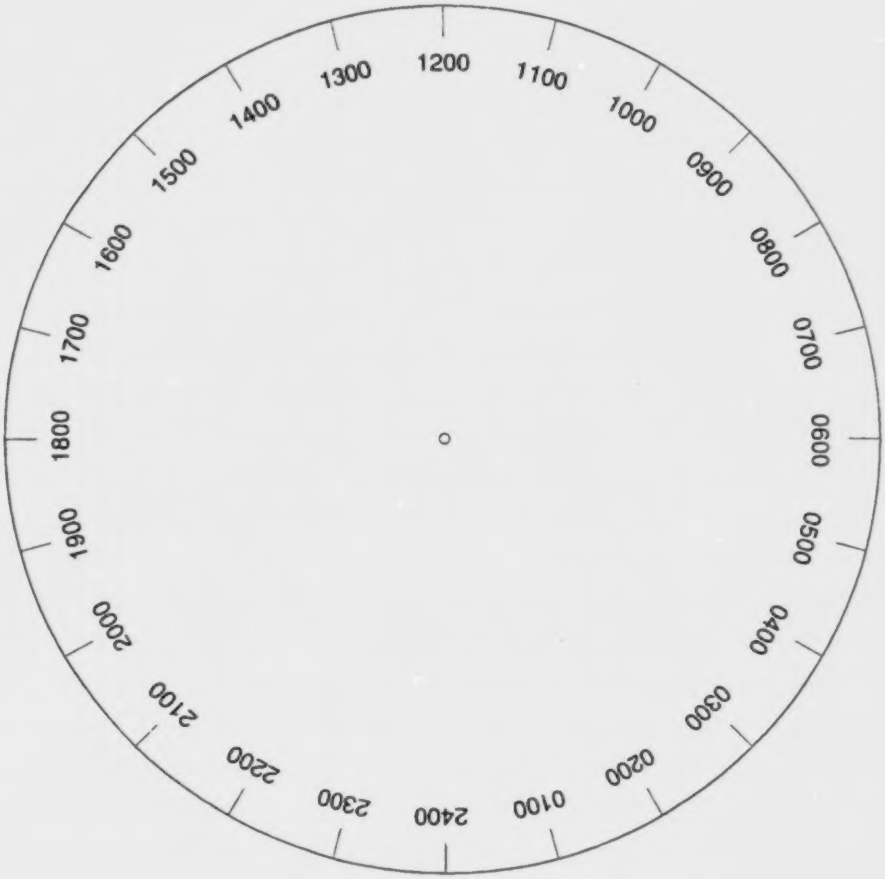

1200
1100
1000
0900
0800
0700
0600
0500
0400
0300
0200
0100
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300

Figure SP 4.2.24A(1) Time circle

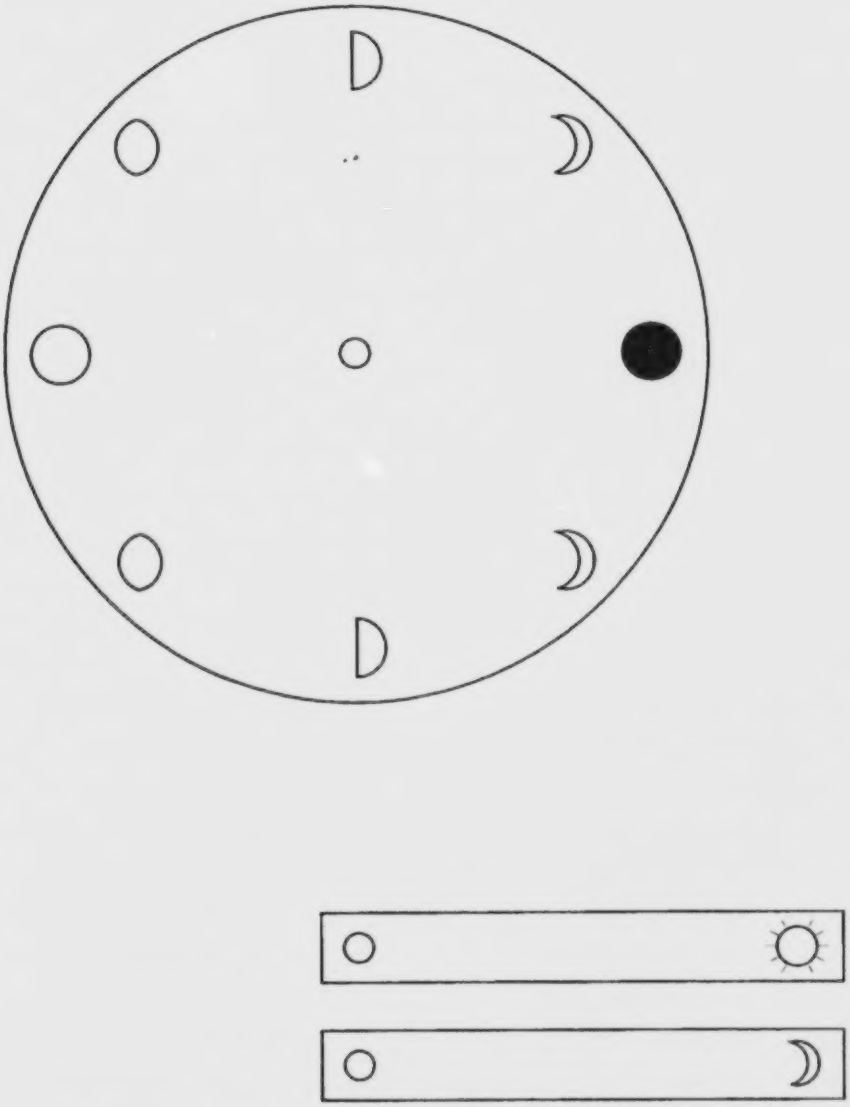


Figure SP 4.2.24A(2) Moon phases and sun and moon hands

DASH

Name________________________

Date________________________

STUDENT PAGE 4.2.24B MOON PHASES AND THE SUN

Use diagrams and explain how moon phases are produced.

Name________________________

Date________________________

DASH

STUDENT PAGE 4.2.25 ECLIPSES

1. Use the table below to record your data on each eclipse you observe.

Kind of eclipse	Date of eclipse	Time eclipse began	Time eclipse ended	Phase of moon

2. Describe how the sun, Earth, and the moon seem to be aligned during eclipses of the sun. Suggest what seems to create the shadow.

____

____

____

____

____

____

3. **Use diagrams to show the alignment of the sun, Earth, and moon during an eclipse of the sun.**

4. **Describe how the sun, Earth, and the moon seem to be aligned during eclipses of the moon. Suggest what seems to create the shadow.**

5. **Use diagrams to show the alignment of the sun, Earth, and moon during eclipses of the moon.**

DASH

GRADE FOUR
CLUSTER 3

Animals

4.3.1 Pet Care
4.3.2 The Unincubated Egg
4.3.3 Chick Embryology
4.3.4 Raising Small Mammals
4.3.5 Housing Pet Mammals
4.3.6 Weekend Care of Pet Mammals
4.3.7 Pairing Pet Mammals
4.3.8 Reproduction of Pet Mammals
4.3.9 Pet Baby Care
4.3.10 Our Early Years
4.3.11 The First Grade Child
4.3.12 Growth, Development, and Behavior of Young Pets
4.3.13 Human Growth and Development
4.3.14 Changing Dimensions
4.3.15 External Anatomy of Fish
4.3.16 Cleaning Fish: Internal Anatomy
4.3.17 Fish Reproduction
4.3.18 Modeling Our Digestive System
4.3.19 Our Digestive System in Two Dimensions
4.3.20 Digestive, Circulatory, and Respiratory Systems
4.3.21 Length of the Digestive Tract
4.3.22 Migration and Hibernation
4.3.23 Fall Birds
4.3.24 Winter Birds
4.3.25 Spring Birds

ACTIVITY 4.3.1 PET CARE

OBJECTIVES

The students
- Take responsibility for the care of their classroom animal.

BACKGROUND

DASH students have probably been taking care of classroom pets since kindergarten. However, it is good practice to review responsibilities and procedures before animals are introduced. This activity should precede all animal projects.

If the students have not had animals in the classroom before, have them research their animals' needs. Information can be gotten from pet stores, reference books, and friends who have previously taken care of animals.

Caution
Check with your school office for state or local guidelines on selecting and handling animals. Gloves should be worn when working with animals that might bite. Always wash your hands after handling animals.

STUDENT ROLES

Farmer
Animal breeder
Pet owner

MATERIALS

Student Page 4.3.1 PET CARE

PRODUCTS

Well-cared-for animals
Responsibility Chart
Completed Student Pages

PROCEDURES

1. **Introduce the animal project. Indicate that the class must set up a Responsibility Chart for animal care.**

   Help the students include such things as
   - Water.
   - Food.
   - Ventilation or aeration.
   - Proper temperature.
   - Various special needs for nesting, gnawing, grinding (for birds), and so forth.

2. **If the animal is a mammal, introduce it and discuss how to handle it.**

   Include
   - Any requirements for using gloves.
   - How to catch the animal.
   - Where and how to hold it.

3. **Have the students use Student Page 4.3.1 to describe how they care for their pet animal.**

4. **Have the students share their knowledge. When possible, have experienced animal caretakers work on teams with their inexperienced peers.**

EXTENSION

- Have the students report on how pet stores or zoos care for their animals.

Name____________________

Date____________________

DASH

STUDENT PAGE 4.3.1 PET CARE

Describe what must be done to care for your pet animal.

ACTIVITY 4.3.2 THE UNINCUBATED EGG

OBJECTIVES

The students
- Review working definitions associated with reproduction.
- Review organism development and make a concept map about it.
- Begin their study of chick embryology.

BACKGROUND

This activity continues the investigation of reproduction and development started in kindergarten. In this activity, the students investigate an unincubated chicken egg. Then in Activity 4.3.3 CHICK EMBRYOLOGY, they observe the 21-day development of the chick during incubation.

To begin this activity, the students review previous studies done on the reproduction and development of organisms. They first review and refine their vocabulary. If the students have had DASH before, their Working Dictionary should include many of the terms used in this activity. If not, they should add these terms to their Working Dictionary. Have the students use standard dictionaries for definitions. It is best to have several dictionaries on hand to make definitions as broad as possible. Have the students use Student Page 4.3.2 THE EGG to record their definitions and examples.

With the students review past studies of reproduction. DASH studies include
- Flowering plants: grades 2–4
- Insects: grades K–4
- Fish: grades 2–4
- Frogs: grades 3–4
- Chickens: grades 3–4
- Mammals: grades K–4

If the students have not had DASH, have them make concept maps of new terms using information from their own experience.

Have the students open an unfertilized egg and identify the parts. Figure 4.3.2 shows a cross section of an egg. The students' diagrams should have some resemblance to the figure. Unfertilized eggs are the eggs normally sold in grocery stores.

STUDENT ROLES

Chicken farmer
Developmental biologist
Embryologist

MATERIALS

Unfertilized eggs (from the grocery store)
Chart paper for concept mapping
Saucer or small plastic plate
Hand lenses
Tweezers
Working Dictionary
Student Page 4.3.2 THE EGG

PRODUCTS

Concept maps about organism development
Completed Student Pages

PROCEDURES

1. **Help the students refine their working definitions of the language of reproduction and embryology.**

   Include such terms and meanings as
   - **Organism:** a living thing; a plant or animal; any single individual.
   - **Male:** a producer of sperm, milt, or pollen; pollen-producing parts of plants; anther; plants and animals that produce only pollen or sperm.
   - **Female:** a producer of eggs, or ova; egg-producing parts of plants and animals; plants and animals that produce only eggs; bearer of offspring in mammals.
   - **Reproduction:** producing again, copying, duplicating, replicating; the way plants and animals make a copy of themselves.
   - **Development:** growth through a series of changes; the growth and change of an organism as it matures.
   - **Metamorphosis:** sudden changes in the way a thing looks; changes in the way parts are put together in a structure; changes that occur as an organism matures; examples—metamorphosis in insects and in amphibians.

- **Embryo:** a plant or animal in an early part of its development; the part of a seed that will develop into a plant.
- **Fertilization:** the joining of an egg and sperm; the result of mating or pollination.

Have the students record their definitions in the Working Dictionary.

2. **Have the students make a concept map of reproduction and development for each group of organisms they have studied.**

   Help them include such organisms and connected concepts as:
   - **Flowering plants:** fertilization; female—ovary, egg or ovum; male—pollen, sperm; insect pollinators; development, seed—embryo.
   - **Insects:** mating, fertilization; female—egg laying; egg; male—sperm; metamorphosis, development—larva, pupa, chrysalis, adult.
   - **Fish:** fertilization; male—testes, milt, sperm; female—spawning, ovaries, egg; development—embryo, fry, adult.
   - **Frogs:** mating, fertilization; male—sperm; female—ovary, egg mass; metamorphosis; development—embryo, pollywog, tadpole, adult.
   - **Chickens:** mating, fertilization; male, sperm; female, egg; chick, adult.
   - **Mammals:** mating, fertilization; male—sperm; female—egg; development—embryo, fetus, baby, young, adult.

3. **Discuss similarities and differences between different kinds of organisms.**

4. **Introduce the chick embryology investigation. Have the students speculate about the chicken egg.**

   Ask such questions as
   - Does a chicken egg have parts?
   - What might a chicken egg look like when it is opened?
   - What do you think happens inside an egg as a chick is developing?

5. **Give the students an unopened unfertilized egg and ask them to draw it on Student Page 4.3.2 THE EGG.**

6. **Ask the students to open the egg and observe its contents. Provide a magnifying glass for close inspection.**

   Have the students
   - Gently crack the egg and open it onto a white saucer or white surface covered with plastic wrap. Tell them to try to keep from breaking any parts. (Provide another egg if the yolk breaks.)
   - Share what they find.

7. **Have the students draw the opened egg.**

   Help them find, label, and make hypotheses about the functions of the
   - Shell.
   - Shell membrane.
   - Air space.
   - Chalaza (dense, ropey tissue that holds the yolk in place).
   - Egg white (albumen).
   - Yolk.
   - Yolk membrane.
   - Germinal disk (white spot on yolk).

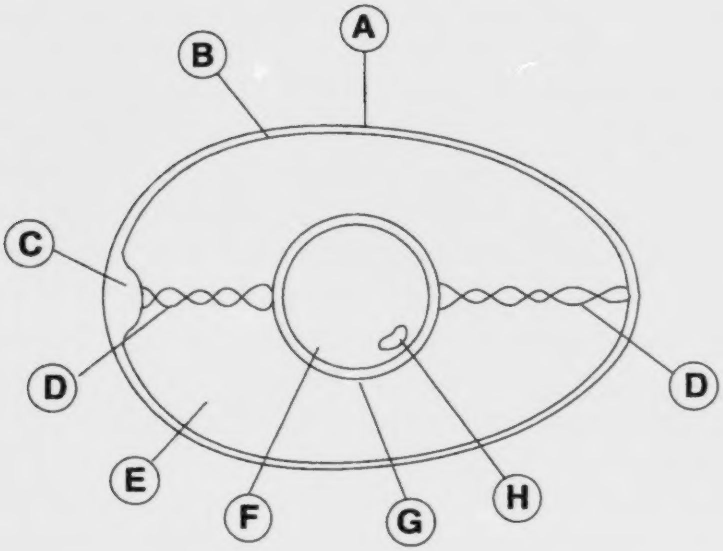
8. **Have the students draw an egg as it might look if we could see inside it without breaking the shell. See Figure 4.3.2.**

9. **Have the students clean up.**

   Have them
   - Save the egg material for animal food or compost.
   - Clean and store equipment.

EXTENSIONS

Have the students make an eggshell collection, asking them to
- Identify the location of the find.
- Identify the finder and date of the find.
- Identify the organism that produced the egg, if known.
- Draw the egg's shape.
- Record the egg's size.
- Invent a way to display the shells.



PARTS	FUNCTIONS
Ⓐ Shell	Protective covering
Ⓑ Shell membrane	Controls gas and moisture passage in and out of the egg
Ⓒ Air space	Cushions movement of yolk and albumen
Ⓓ Chalaza (dense ropey tissue attatched to the yolk membrane)	Holds the yolk in the center of the egg
Ⓔ Egg white (albumen)	Food source
Ⓕ Yolk	Food source
Ⓖ Yolk membrane	Tissue surrounding the yolk
Ⓗ Germinal disk (white spot on the yolk)	Where the embryo will develop

Figure 4.3.2 Structure of an egg

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.2 THE EGG

Record your working definitions for the following terms:

1. **Organism**

____

____

____

2. **Male**

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____

____

3. **Female**

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____

____

4. **Reproduction**

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Name ____________________

5. **Development**

____

____

____

6. **Metamorphosis**

____

____

____

7. **Embryo**

____

____

____

8. **Draw an unopened egg.**

Name ______________________

9. **Draw an opened egg and identify the parts listed in Item 11.**

10. **Draw the inside of an egg as it might appear through an unbroken transparent shell. Label the parts listed in Item 11.**

Name ______________________________

11. Suggest a function for each of the parts of the egg listed below.

PART	FUNCTION
A. Shell	
B. Shell membrane	
C. Air space	
D. Chalaza (dense ropey membrane attached to the yolk)	
E. Egg white (albumen)	
F. Yolk	
G. Yolk membrane	
H. Germinal disk (white spot on yolk)	

ACTIVITY 4.3.3 CHICK EMBRYOLOGY

OBJECTIVES

The students
- Observe chick embryos.
- Identify the order in which major parts of the chick embryo develop.
- Label diagrams of the developing chick embryo.
- Observe chicks through their first weeks after hatching.

BACKGROUND

This activity is the second on the embryology of chickens. In it the students study the 21-day development of the chick. The chicken is a vertebrate and shows in its embryological development many of the same structures that are found in the embryos of humans and other mammals. Unlike mammals, which have eggs of pinpoint size, the chicken has a relatively huge egg mass that allows us to watch the development on a grand scale from the beginning.

The rapidity with which the undifferentiated material of the yolk is organized into a fully developed chick is startling. In just 21 days, the chick goes from a single cell to an organism made of some 100 billion cells. See Figure 4.3.3(1) for diagrams of the early development of the chick embryo.

Approach (1)—Opening Eggs for 10 Days

Have the students incubate fertile eggs and open them regularly to observe the developing embryo. Development will show marked changes over the first 10–11 days. After that, the principal change will be the increasing size of the fully recognizable chick. It is suggested that the last incubated eggs be opened on the 10th or 11th day.

After the 11th day, eggs can be placed on a bright overhead projector to show the shadow of the growing chick within the egg. Create a shield around the egg so that only light passing through the eggshell is seen. This can be done by cutting a hole in a shallow cardboard lid. See Figure 4.3.3(2). The shadow will not project well on a screen, but the shadow outline can be drawn on the surface of the egg and traced.

Approach (2)—Observing Embryo Shadows

A second way is to incubate several eggs and observe embryo shadows on the egg's surface through the entire period of development. This can be done without opening any eggs.

For shadow drawings it is suggested that the same egg be used all the way through the 21-day cycle. This will reduce the possibility of variation that might be found using different eggs.

Incubation Schedule

If you choose to open eggs every other day, you will need two batches of eggs. Start the first brood of eggs on a Monday. This will provide eggs for opening every other day except for Day 5, which will fall on the first Saturday of the observation period. Start the second brood on Wednesday to provide the Day 5 egg on the second Monday. Open both the Day 5 and the Day 7 eggs on the second Monday. All eggs unopened after the 11th day should be allowed to incubate to the 21st day. See Tables 4.3.3–1 and 4.3.3–2.

It is a good idea to incubate extra eggs in case you have to open more than one egg on any one day. If you plan to observe embryo shadows only and don't plan to open any eggs, you will need only four or five eggs for a brood.

Table 4.3.3–1 Hatching schedule to produce embryos 1, 3, 7, 9, 11 days old

	BROOD 1: EIGHT OR NINE EGGS							
Egg age in days	0	1	2	3	4	5	6	
Day of the week	M	T	W	Th	F	S	Sun	
Procedure	St	O	...	O	...	...	...	
Egg age in days	7	8	9	10	11	12	13	
Day of the week	M	T	W	Th	F	S	Sun	
Procedure	O	...	O	...	O	...	...	
Egg age in days	14	15	16	17	18	19	20	21
Day of the week	M	T	W	Th	F	S	Sun	M
Procedure	...	...	...	...	...	...	...	H

St = Start O = Open H = Hatch ... No action taken

Table 4.3.3–2 Hatching schedule to produce a 5-day embryo for the second Monday's opening

	BROOD 2: THREE OR FOUR EGGS							
Egg age in days			0	1	2	3	4	
Day of the week	M	T	W	Th	F	S	Sun	
Procedure	...	...	St	...	...	...	...	
Egg age in days	5	->	->	->	->	->	->	21
Day of the week	M	Remaining eggs go to hatching						W
Procedure	O	->	->	->	->	->	->	H

St = Start O = Open H = Hatch

Start the sequence by opening an unincubated egg. See Activity 4.3.2 THE UNINCUBATED EGG.

Films and Videotapes

Films and videotapes should be shown after the process of incubation has been completed. This keeps alive the sense of anticipation during both the opening and shadow-viewing processes.

Incubators

It is suggested that a commercial incubator be used. Instructions for operation will come with the device. Remind the students that the region beneath a hen's body is humid and that a dish of water must be kept in the incubator to produce the same kind of humidity. (Humidity can be checked using cobalt chloride paper.) The eggs should be turned every day. Place an *X* on one side of the egg. On even days the *X* can be up, and on odd days the *X* can be down.

Sources of Eggs

Fertile eggs in rural and suburban regions can usually be obtained from a commercial hatchery or a local farmer. In urban areas contact your local district science specialist.

Follow-up Observations

Hatched chicks can be kept for up to three weeks in a brooder made from a cardboard box. See Figure 4.3.3(3). During this time, the students should carry out studies stemming from their previous experience with chicks in DASH 3. Such studies may include growth rate studies (change in size, change in weight), food intake, change in feathering, changes in food preferences, development of sex differences (comb, feathering, voice), and so forth. Outlines of the studies should be worked out before the chicks hatch.

Brooders

A diagram for a simple but adequate brooder is shown in Figure 4.3.3(3). A brooder capable of housing 4–5 chicks can be made out of a deep cardboard box with a base measuring at least 2 ft X 2 ft. For sanitation purposes the box can be lined with plastic and a covering of newspaper. The newspaper should be replaced regularly.

Water for the Chicks

A watering container should be placed in one corner of the brooder and secured so that it will not fall over if the brooder is jarred. Water can be a problem for chicks. If they get wet they can catch cold and die.

A watering container can be made from a jar and a lid bigger than the opening of the jar. Fill the jar with water. Put a Popsicle stick or tongue depressor across one lip of the jar to make an air passage. Turn the jar upside down so the lid is on the bottom. Water will immediately flow into the lid but will quickly stop. As the chicks drink, air bubbles will rise in the jar, releasing more water. The chicks will have only a narrow space to drink from and cannot get into the water and get wet. See Figure 4.3.3(3).

STUDENT ROLE

Embryologist

MATERIALS

Library books on raising and hatching chicks
Videotapes and films on the developing embryo of the chick
Commercial incubator
10–12 fertile eggs
2 cardboard boxes (one large box with a smaller one to fit inside)
15-watt bulb
Tin can
Light socket with plug
Cloth strips to make fringe
Tape
Wire
Overhead projector
Shallow cardboard box lid
Tongue depressors or Popsicle sticks (2)
1-quart glass jar to use as water bottle
Lid half inch wider than mouth of jar
Chick mash

Food dish
Student Page 4.3.3 CHICK EMBRYOLOGY

PRODUCTS

Chick Embryo Class Chart
Completed Student Pages

PROCEDURES

1. **Have the students establish a committee to organize for the incubation of the eggs.**

   Be sure that the students consider such things as
   - How to operate the incubator. (Help them read and interpret the instructions that go with the incubator.)
   - Where the incubator is to be placed. (Take into consideration the need for electricity and protection against jarring.)
   - Responsibility for egg maintenance, including weekend care.
   - Making an egg holder to use in viewing the embryo shadows.

2. **Have the students establish a second committee to organize for care of the chicks once they are hatched.**

   Be sure that the students consider such things as
   - Making a brooder for hatched chicks.
   - Responsibility for hatched chicks.
   - How chicks are to be identified. (A drop of food coloring on the heads of the chicks can be used to identify individuals. Regularly restore the markings with fresh drops of coloring).
   - Investigations to be done after the chicks have hatched. (Include such things as change in size and weight, amount of food eaten, development of feathers.).
   - How the chicks are to be distributed after the studies are completed.

3. **Show the shadow of the developing embryo each day and have the students trace the shadow.**

   Help them
   - Identify and label the parts of the embryo that are visible.

4. **If eggs are to be opened, follow the schedules in Tables 4.3.3–1 and 4.3.3–2. Have the students draw or photograph the embryos.**

   Help them
   - Identify the major anatomical parts—spinal column, head, body, eyes, and wing and leg buds.
   - Watch for the first evidence of a beating heart.

5. **Photocopy some or all of the shadow drawings and have the students assemble them in order on Student Page 4.3.3 CHICK EMBRYOLOGY.**

6. **Review the activity using a film or videotape.**

7. **Have the students put the newly hatched chicks in the brooder and begin their studies on chick development.**

   Have them
   - Make appropriate tables for record keeping.
   - Carry out the investigations they decided on in Procedure 2.
   - Make summary reports on their investigations.

8. **Carry out a plan to distribute the chicks after the study is completed.**

EXTENSION

- Make a wall display showing the embryology of the chick and its first several weeks of development.

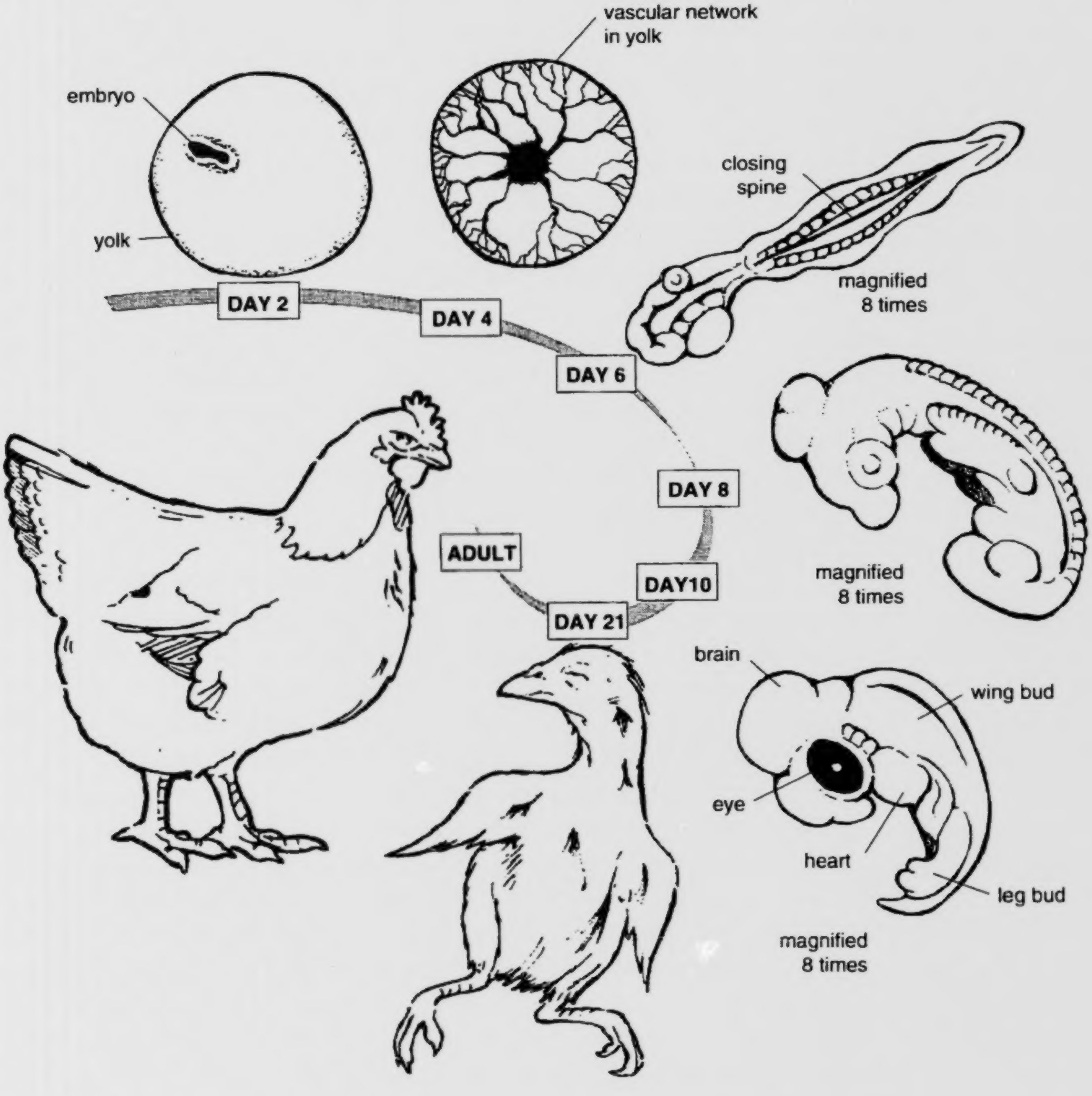
vascular network in yolk
embryo
yolk
closing spine
magnified 8 times
DAY 2
DAY 4
DAY 6
DAY 8
DAY10
DAY 21
ADULT
magnified 8 times
brain
wing bud
eye
heart
leg bud
magnified 8 times

Figure 4.3.3(1) Stages in developing chick embryo

BEST COPY AVAILABLE

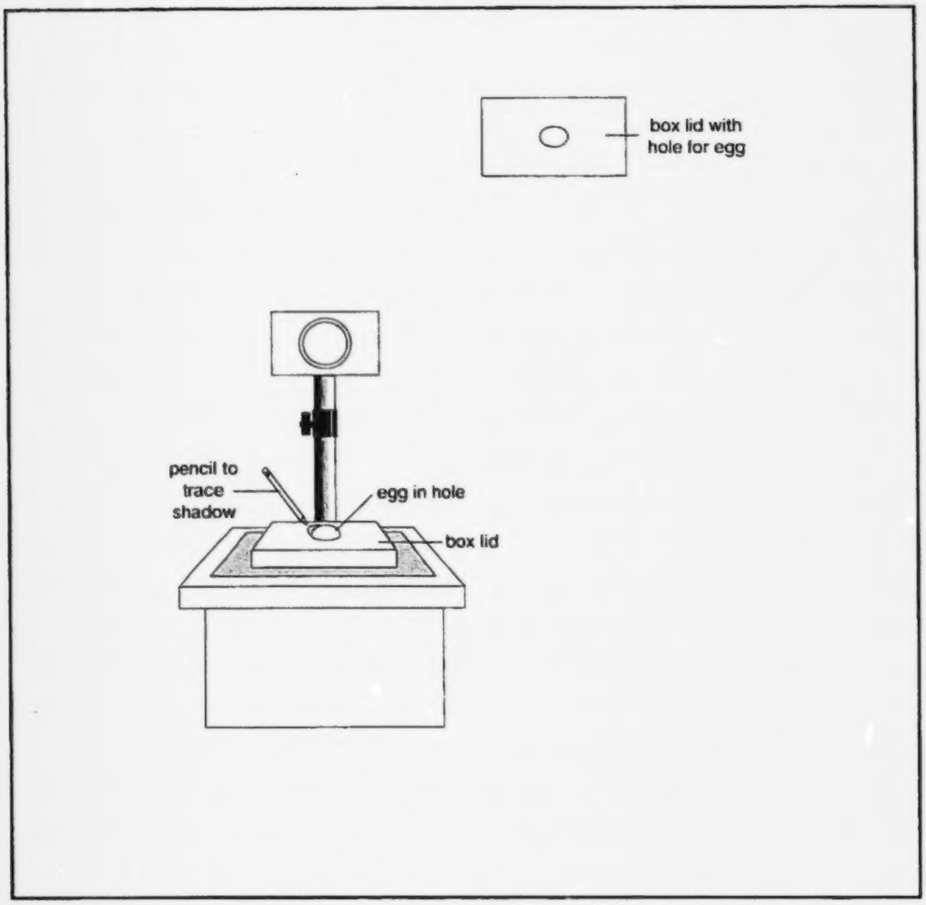
box lid with
hole for egg
pencil to
trace
shadow
egg in hole
box lid

Figure 4.3.3(2) Method for viewing chick embryos

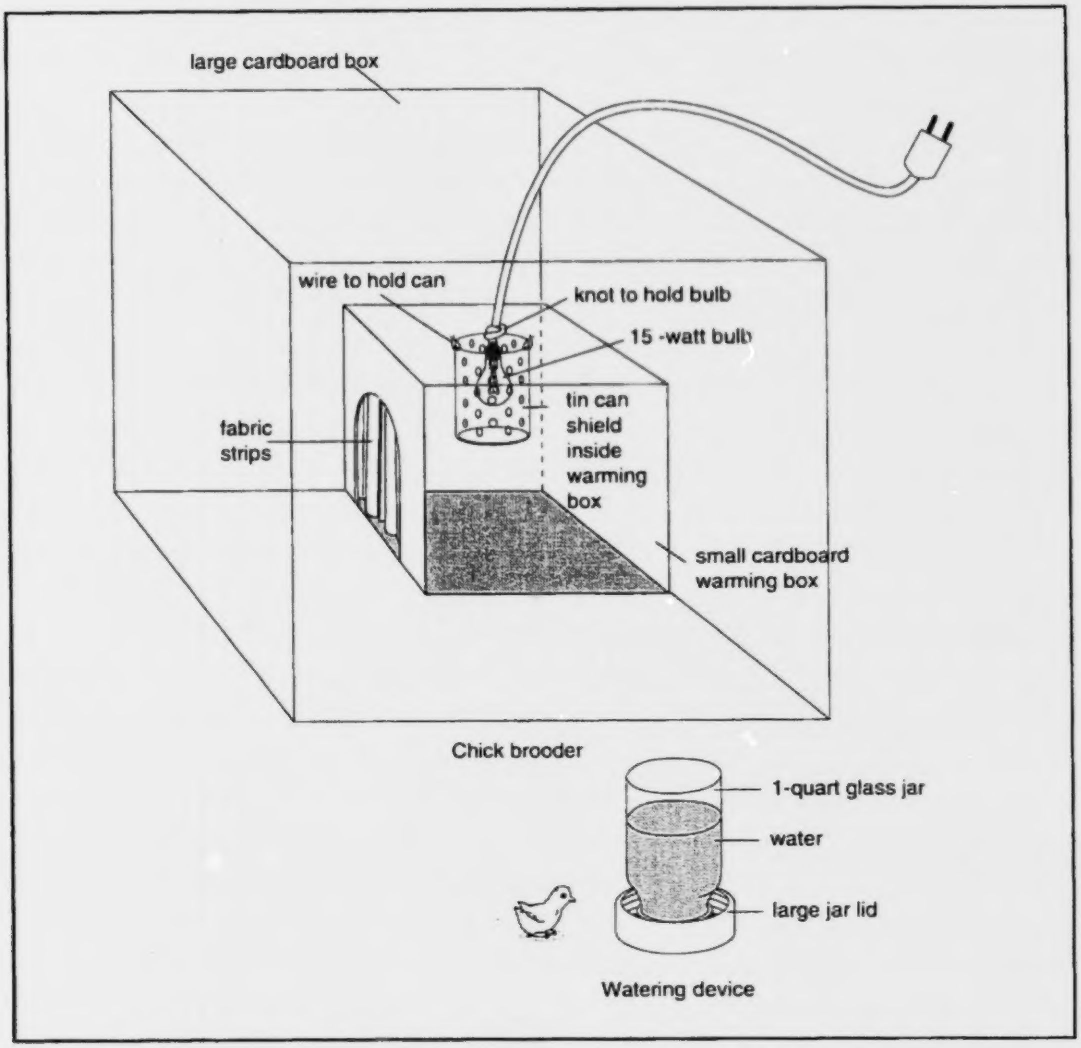
large cardboard box
wire to hold can
knot to hold bulb
15 -watt bulb
fabric strips
tin can shield inside warming box
small cardboard warming box
Chick brooder
1-quart glass jar
water
large jar lid
Watering device

Figure 4.3.3(3) A chick brooder and watering device

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.3 CHICK EMBRYOLOGY

1. **Paste your shadow diagrams on this page in the order of the embryo development.**

Name ______________________

2. **Describe your study of the developing chick.**

ACTIVITY 4.3.4 RAISING SMALL MAMMALS

OBJECTIVES

The students
- Review the characteristics of mammals.
- Research and report on the needs of a small mammal.

BACKGROUND

This activity follows the more general Activity 4.3.1 PET CARE which is addressed to the preparation for and maintenance of any animal in the classroom. In RAISING SMALL MAMMALS the students are preparing to raise mammals and observe reproduction and development of young. At all times animals should be treated as pets.

Gestation

Because mice develop rapidly, they are good for observation of mammalian growth and reproduction in the classroom. Other animals that can be used are guinea pigs, gerbils, and rabbits. For mice, gestation ranges from 19 to 21 days, and the pups reach maturity in about 60 days. A litter of mouse pups usually numbers five or six, and females can produce up to ten litters a year. Guinea pigs have a gestation period of 65 to 70 days; gerbils, 24 days; and rabbits, 30 days.

Housing

Animals can be kept in a variety of cages or pens. Wood shavings or pet litter on the cage floor will absorb moisture and help eliminate odor. Animals thrive in a complex environment with exercise wheels and other simple playthings such as paper tubes.

Feeding

Small mammals eat seeds and grains or commercial mixes. Most like vegetables such as carrots or lettuce. Clean, fresh water is essential. A piece of wood in the cage will satisfy the animals' desire to gnaw.

Go to the pet store ahead of time to discuss how to house, feed, and care for different animals. This will help in selecting an appropriate classroom pet. Paired animals will produce offspring. The young animals should be removed from the classroom within three or four weeks to prevent a population explosion. Ask your pet shop in advance whether they take extra animals. Better yet, some children (and their parents) may want **single** animals.

Handling
Check with your local school or district office for any regulations concerning the selection and handling of animals. It is good practice to use gloves. Hands should always be washed after animals are handled.

STUDENT ROLE

Zoologist

MATERIALS

Butcher paper
Reference books
Student Page 4.3.4 SMALL MAMMAL REPORT

PRODUCTS

Concept map about mammals
Student reports on keeping small mammal pets

PROCEDURES

1. **Review the characteristics of mammals and create a concept map about them.**

   Help the students include such things as
   - Care of their young.
   - Nurse their young.
   - Are trainable.
   - Have fur.
   - Their body parts.
   - Kinds of mammals, including humans.

2. **Tell the students that the class will soon raise a pet mammal and assign research on the needs of the animals to be considered.**

   Discuss possible ways of getting information including the following:
   - Talking to pet store owners.

- Going to the library to find books about the animals.
- Talking to friends who raise the animals being considered. (This is a good time to have students from other classes who have raised animals come in and talk about their experiences.)

3. **Have the students decide what information is to be reported about the animals being considered.**

   Help them include such things as
   - What the animal eats.
   - How big the adult animal would be.
   - How much space each animal would need.
   - What the animal's environment should be like.
   - The kind of caging that would be needed.
   - Whether the animal could be handled. If so, any particular way it should be handled.
   - Any special requirements the animal might have. (Exercise, light, and so forth.)
   - How long it takes such animals to reproduce. (Gestation period.)
   - Any special reproduction behavior of such animals.
   - How long it takes such animals to reach adulthood.
   - Who might have personal experience with such animals.
   - The temperament of such animals. (Are they easily tamed?)

4. **Have the students use Student Page 4.3.4 SMALL MAMMAL REPORT to report their research.**

5. **On the basis of research help the class select a small mammal to be a class pet.**

EXTENSIONS

- Have the students make a bulletin board display of their reports.

Name______________________

Date______________________

DASH

STUDENT PAGE 4.3.4 SMALL MAMMAL REPORT

Write a report on an animal that might be selected as a pet. Include its size as an adult, its temperament, time it requires to reach adulthood, space requirements, cage requirements, food requirements, special environmental requirements, reproduction time, and other information needed to make a good selection.

ACTIVITY 4.3.5 HOUSING PET MAMMALS

OBJECTIVES

The students
- Discuss the housing needs of their pet mammals.
- Design pet housing.
- Build pet housing.

BACKGROUND

This activity is the second in the series on the life cycle of mammals. In it the students design and build housing for their animals. The activity should follow 4.3.4 RAISING SMALL MAMMALS and precede 4.3.6 WEEKEND CARE OF PET MAMMALS.

Types of Housing

Cages can be expensive. It costs less to have the students build their own animal housing. Guinea pigs can be kept in a child's swimming pool with rigid sides. No cage is needed. The environment can be shaped with various structures designed by the students. Rabbits can also be kept in a child's swimming pool. Use a wire-mesh covering to keep animals inside the pool.

Mice and gerbils can be housed in chambers made of different-sized plastic bottles with one bottle slid into another. Glue guns and duct tape can be used to secure the pieces. Plastic can be punctured and then cut with scissors. The plastic chambers can be taken apart for cleaning if duct tape is used to secure the joints.

All the animals discussed are rodents, and they will gnaw at any hard material—paper boxes, wood, even metal and plastic. The animal house should be checked periodically and gnawed parts replaced so that animals do not escape. Be sure to include pieces of wood for animals to gnaw on.

STUDENT ROLES

Designer
Builder

MATERIALS

Small-mesh wire
Pliers
Treadmill materials
2-liter plastic bottles or cardboard boxes
Water bottle
Newspaper
Wood chips
Additional materials as needed
Plastic juice bottles
Child's swimming pool with rigid sides
Scissors
Duct tape
Hot-glue gun and glue sticks
Student Page 4.3.5 HOUSING PET MAMMALS

PRODUCTS

Animal housing
Completed Student Pages

PROCEDURES

1. **Discuss the housing for the kind of pet chosen. Explain that class pets can be expected to reproduce.**

   Ask such questions as
   - What special rooms does a house need? (Exercise, nursery, feeding, and so forth.)
   - Where should the animals be fed and watered?
   - How can we clean the house?
   - What can we provide for the animals to chew on?
   - How can we provide for privacy?
   - What kind of housing can we build for our animals?
   - How big should the animal house be?
   - What kind of materials can we use? (Paper, cardboard, plastic, wood, wire, and so forth.)
   - What should the house have in it?
   - How can we get the animals in and out of the house?
   - How can the animals get from room to room?
   - How can we ventilate our animal house?

2. **Present the Inventor's Box containing construction materials and have the students design the animal house.**

   Have the students
   - Plan how they are going to divide the design work.
   - Assign the design tasks for different rooms.
   - Design the rooms. (This should include drawings and possibly models.)
   - Decide what materials will be used.
   - Decide how materials can be obtained.
   - Present designs for class discussion and modification.
   - Plan how to assemble the house.
   - Form assembly teams.

3. **Have the students build house compartments and assemble them.**

   Have them
   - Build their individual units.
   - Inspect the units for safety and security.
   - Assemble the entire house.
   - Check to make sure the animals can satisfy their basic biological needs for air, water, food, reproduction, exercise, sanitation, and thermal protection.
   - Check the practicality of procedures for cleaning and waste disposal.

4. **Have the students test the housing system with an animal and make modifications as needed. Have them complete Student Page 4.3.5 HOUSING PET MAMMALS.**

EXTENSIONS

Have the students
- Make a display of design drawings.
- Invite other classes and parents to see the design drawings and the completed house.

Name________________________

Date________________________

DASH

STUDENT PAGE 4.3.5 HOUSING PET MAMMALS

1. Record your design for a room of the animal house.

2. What is the purpose of this room? How does it fulfill that purpose?

3. How can the room be cleaned?

Name ______________________

4. Describe how the animal house provides for the following:

Water

Air

Exercise

433

Name ______________________

Waste Disposal

Nesting site for raising young

Privacy (especially for mice)

ACTIVITY 4.3.6 WEEKEND CARE OF PET MAMMALS

OBJECTIVES

The students
- Discuss care of pets during weekends and vacations.
- Establish “take home” rules.
- Invent housing for pets' home visits.
- Build or modify housing for pets' home visits.

BACKGROUND

This activity is part of series on the life cycle of mammals. It should come after 4.3.5 HOUSING PET MAMMALS and precede 4.3.7 PAIRING PET MAMMALS.

It is essential to provide for the needs of animals over weekends and vacations. The animals can be left at school if food, water, and heat are adequate. However, in many schools it will be necessary or preferable to have them taken home. A home stay will require the further invention of housing. Carrying animals to and from home can be done in ventilated cardboard boxes, but the caging in the home should be more secure. Building designs similar to those worked out in Activity 4.3.5 HOUSING PET MAMMALS can be used.

- Discuss how to maintain animals over weekends. Often they can be left at school.
- Discuss times when there will be no heat in the building, what to do over long vacations, and so forth.
- Discuss home visits for animals.
- Note that some students may have taken animals home in previous years.

STUDENT ROLES

Pet keeper
Animal caretaker

MATERIALS

Small-mesh wire
Pliers

Treadmill materials
Plastic bottles or cardboard boxes
Water bottle
Newspaper
Duct tape
Hot-glue gun and glue sticks
Scissors
Student Page 4.3.6 PET HOME VISITS

PRODUCTS

Portable housing for pets' home visits
Completed Student Pages

PROCEDURES

1. **Discuss weekend and vacation care of class pets.**

   Ask such questions as
   - How can we be sure that the animals will be cared for when school is not in session?
   - How can we be sure that their water supply is adequate?
   - How can we be sure that their food supply is adequate?
   - When might there be problems in caring for the animals? (When the heat is turned off in the building or the water supply malfunctions.)
   - What might be done to solve these problems? (Work toward a home pet-care system if appropriate.)
   - How can animals be taken to and cared for in someone's home?

2. **Establish "take home" rules.**

   Have the students
   - Identify what must be done to care for the pets at home.
   - Decide who is to take the pets for home visits.

3. **Ask the students to invent portable housing for pets' home visits. Hold a design contest with drawings and models.**

   Be sure the students have considered
   - Watering.
   - Feeding.

- Temperature control.
- Air.
- Cleaning and waste disposal.
- Exercise.
- Care of any young.

4. **Have the students build or modify housing for pets' home visits.**

EXTENSION

- Have students who take class pets home report on the animals' response to changes in their environment.

Name________________________

Date________________________

DASH

STUDENT PAGE 4.3.6 PET HOME VISITS

1. Draw and label your design for portable housing to maintain pet mammals at home.

2. List the rules for caring for pets at home.

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ACTIVITY 4.3.7 PAIRING PET MAMMALS

OBJECTIVES

The students
- Make a pet care responsibility chart.
- Introduce paired pets to their new environment.
- Establish responsibility routines for pet care.
- Identify the sex of animals.

BACKGROUND

The activity is part of the series on the life cycle of mammals. It should come after 4.3.6 WEEKEND CARE OF PET MAMMALS and before 4.3.8 REPRODUCTION OF PET MAMMALS.

Responsibility Charts

When possible, the students should lead in making a responsibility chart and organizing for the care of the animals. Additional observations can be added to the chart as the students find out more things about their animals.

Identification of Female

To ensure that both a male and female are present, the animals need to be sexed. The excretory openings and reproductive organs of most mature animals will be sufficiently prominent to allow easy identification. Females will have two large external openings: the excretory opening of the anus, and right, below it, the vulva or urogenital opening. The vulva is the opening leading to the vagina or reproductive canal.

Identification of Male

Males will have only one large external opening, the anus. In older males the scrotum or external pouch holding the testicles will be obvious.

STUDENT ROLES

Pet keeper
Animal caretaker
Ethologist

MATERIALS

Two pet rodents, a male and a female
Food
Water
Newspaper
Food coloring
A cage or other housing
Student Page 4.3.7 PAIRING PET MAMMALS

PRODUCTS

Young mammal pets
Completed Student Pages

PROCEDURES

1. **Help the students plan for the care of their mammal pairs.**

   Have them develop a Responsibility Chart that includes
   - Feeding.
   - Watering.
   - Handling. (Gloves may be needed. Some mice and gerbils that have not been tamed tend to bite. Animals must be handled gently and often to become tame. Young animals are much easier to tame than older animals.)
   - Cleaning.
   - Observations to be made.
   - Measuring and recording.
   - Weekend home care.

2. **Have the students develop a list of daily observations.**

   Help them include such things as
   - Condition of the housing. (The way the animals organize their environment.)
   - Time spent in exercising.
   - Amount of food eaten and how this will be measured. (The amount of food can be weighed or measured volumetrically.)
   - Amount of water drunk and how this will be measured. (The amount of water added to the drinking bottle can be observed and recorded.)
   - Evidence of nesting.

- Evidence of favorite rooms.

3. **Establish a mammal pair.**

   Help the students
   - Identify external reproductive and excretory organs:
     Male—penis, testicles, anus.
     Female—vulva, anus.
   - Practice handling.
   - Practice taming.
   - Mark the animals for identification with a drop of food coloring.
   - Release the animals into their special housing.

4. **Have the students begin caring for, observing, and recording observations of the animals. Have them use Student Page 4.3.7 PAIRING PET MAMMALS.**

5. **Establish a regular time for summarizing observations.**

EXTENSIONS

- Have the students keep a photographic record of the behavior of the mammal pair.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.7 PAIRING PET MAMMALS

Record your observations of the class pets.

DATE	NAME OF PET	OBSERVATIONS

ACTIVITY 4.3.8 REPRODUCTION OF PET MAMMALS

OBJECTIVES

The students
- Observe a pregnant mammal.
- Observe nesting behavior.
- Observe changes in the female's size.
- Observe the birth process.

BACKGROUND

This activity is part of the series on the life cycle of mammals. It should follow 4.3.7 PAIRING PET MAMMALS and precede 4.3.9 PET BABY CARE.

In REPRODUCTION OF PET MAMMALS the students prepare for the birth of young mammals. They should be given the opportunity to ask questions and make predictions before observing the events starting with pregnancy and nest building followed by the birth and post-birth care of young. Questions and predictions prepare the students to take full advantage of opportunities to observe. The students should record observations of normal non-nesting behavior, so they can recognize changes in behavior when nesting begins.

Measuring

Measuring the pregnant female can be done in several ways. If the animal is very tame, the students can weigh it. Otherwise, they should measure or estimate its abdominal width. This can be done as the animal rests on grid paper.

Separation

Remove the male to separate quarters if he fights with the female and certainly immediately after the birth of young. This will prevent him from disturbing the nest and reimpregnating the female. Reimpregnation can occur as early as three days after the birthing.

Birth

Viewing the birth process is a riveting experience for almost all students. When possible it should be observed directly. Most tame pets will not be frightened by several dozen peering eyes, but occasionally a pet will show fright and should be left alone. If possible, videotape the birth process.

Such a tape will help in years when birth occurs at a time the students are not in class.

STUDENT ROLES

Animal caretaker
Ethologist

MATERIALS

Pair of pet mammals
Balances
Tape measures
Student Page 4.3.8 REPRODUCTION OF PET MAMMALS

PRODUCTS

Young pets
Completed Student Pages

PROCEDURES

1. **Alert the students to watch for signs of nesting. Have them observe and keep notes on the nesting behavior.**

   Ask such questions as
   - What is meant by nesting behavior?
   - What do your pets do when nesting?
   - Do both pets behave the same way?
   - What questions do you have about nesting behavior?

2. **Have the students observe the female for changes and discuss the need to be very careful in handling her.**

   Help them seek answers to such questions as
   - Are there any changes in the female? What might they be?
   - Is it possible to measure any changes? If so, how? (Get at measuring weight, width, and girth.)

3. **Remove the male from the shared environment after nesting begins.**

Have the students
- Prepare a separate house for the male.
- Prepare a separate Responsibility Chart for care and observation of the male.
- Remove the male to separate quarters.

4. **Prepare the students for the birth process by helping them record questions about what will happen.**

   Help them ask such questions as
   - How do the young get out of the mother's body?
   - Where will the young leave the body?
   - How many young will be born at one time?
   - What will the young be like when they are first born?
   - What will the mother do as she gives birth?

5. **Prepare for post-birth observations by helping the students record questions and predictions about how the animals will behave. Have them use Student Page 4.3.8 REPRODUCTION OF PET MAMMALS.**

   Help them ask such questions as
   - How big will the young be?
   - Will all the young be of the same size?
   - How many young will be there?
   - Will all the young be alive?
   - What will the young be like?
   - What will happen to the size of the mother after she gives birth?
   - What will the mother do with the young after delivery?

6. **Have the students keep careful watch over the pregnant female for signs that the birth is about to take place.**

7. **If the birth occurs during the day, have the students watch and videotape the process if possible.**

8. **Have the students observe the mother and young in the period following birth and look for answers to their questions.**

9. **Periodically have the students check their predictions by reporting on the answers they have found to their questions.**

EXTENSIONS

Have the students

- Make a bulletin board display of photographs of the young animals.
- Make a videotape of the cycle of events in the reproductive cycle.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.8 REPRODUCTION OF PET MAMMALS

1. Describe the nesting behavior of your pet.

2. How did you measure the changes in the female? On a separate sheet of paper make a table of your measurements. Include the dates, measurements, and changes in measurement. Make a graph of the measurements over time. Use the attached graph paper.

3. Describe the changes in the size and shape of the female during the pregnancy.

Name ______________________

4. **Describe the birth of the babies.**

5. **Describe what the mother did with the babies after they were born.**

Name ____________________

ACTIVITY 4.3.9 PET BABY CARE

OBJECTIVES

The students
- Observe the nursing of young pets.
- Observe how the pet mother cares for her young.

BACKGROUND

This activity is part of the mammal life cycle series. It should follow 4.3.8 REPRODUCTION OF PET MAMMALS and precede 4.3.12 GROWTH, DEVELOPMENT, AND BEHAVIOR OF YOUNG PETS.

In PET BABY CARE the students compile a set of questions to guide their observations of the pet mother's care of her newborn babies. They then make their observations in preparation for reporting on human baby care.

Identification of Young

The young pets can be identified by placing small dots of food coloring on their heads. The mother may lick off the coloring, so the students should be prepared to reapply it.

STUDENT ROLES

Animal caretaker
Ethologist

MATERIALS

Food coloring
Female pets with newborn babies
Student Page 4.3.9 PET MATERNAL CARE

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Have the students observe the babies nursing. Have them watch the mother care for the babies right after birth. This**

will prepare them to develop their own questions about care for pet babies.

2. **Help the students ask questions and make predictions about the behavior of the mother and her babies during the first days following birth.**

   Guide the students to ask such questions as
   - How often do the babies nurse?
   - How long do the babies nurse?
   - How do they nurse?
   - Do all babies nurse at the same time?
   - Can you identify the different babies? If so, how?
   - Do some babies nurse more than others?
   - Do they nurse at the same teat every time?
   - Can we detect differences in the babies that nurse more than others?
   - How often does the mother eat and drink water?
   - Do the babies defecate? If so, where?
   - Where does the mother defecate?
   - Is the nest kept clean? If so, how?
   - What does the mother do when other animals visit the nest?
   - How much of the day does the mother spend with her babies?
   - What kinds of things does the mother do beside eat, feed her babies, and tend the nest?

3. **Have the students observe the mother's care of her young. Help the students find answers to their own questions and record them on Student Page 4.3.9 PET MATERNAL CARE.**

4. **Summarize the observations.**

   Have the students
   - Report on the answers they have found to their questions.
   - Discuss differences in observations and reconcile them where possible.

EXTENSION

- Have the students report on how other mammals (cats, dogs, sheep, cows, goats, and so forth) care for their young.

Name________________________

Date_________________________

STUDENT PAGE 4.3.9 PET MATERNAL CARE

Record your questions and predictions about the newborn baby mammals and the responses of the mother. Record any observations that answer your questions or verify your predictions.

ACTIVITY 4.3.10 OUR EARLY YEARS

OBJECTIVES

The students
- Develop stories about their lives as newborn babies.
- Develop stories about their lives as toddlers.
- Develop stories about their lives as preschoolers.
- Verify their stories with family members and family friends.
- Compare their growing up with that of a pet mammal.

BACKGROUND

This activity is part of the mammal life cycle series. It should follow 4.3.9 PET BABY CARE and precede 4.3.11 THE FIRST GRADE CHILD.

Writing Development Stories

The students write stories about what they think earlier periods in their life were like. They then check their stories with family members and family friends. It is suggested that each student write a story about one period—that of the newborn baby, the toddler, or the preschooler. Have the students also record what they think other periods were like in their lives so that they can better relate to the reports as they are made.

Comparison with Pet Development

The students compare their growing up with that of their pets. Introduce the idea that animal models can be useful in telling us about ourselves although such models have many limitations. The students become aware of how much more complex growing up is for humans than for pets. It should be emphasized that humans have to learn more things than pets do.

STUDENT ROLES

Child psychologist
Parent
Teacher

MATERIALS

Student Page 4.3.10 OUR EARLY YEARS

PRODUCTS

Stories
Completed Student Pages

PROCEDURES

1. **Have the students make separate concept maps of the terms "human baby," "toddler," and "preschooler."**

   Help them include such things as
   - Needs. (Things that have to be done for the child.)
   - Abilities. (Things the child can do at each of these stages.)
   - Limitations. (Things the child can't do at each of these stages.)
   - Learning. (Things the child learns at each of these stages.)

2. **Have a group of students write individual stories titled "When I Was a Newborn Baby." Have them pretend that they are newborn babies and write a story about all the things that happen to them in a day's time.**

3. **Have a second group of students develop stories with the title "When I Was a Toddler." Follow the same procedure as with "When I Was a Newborn Baby."**

4. **Have a third group of students develop stories with the title "When I Was a Preschooler." Follow the same procedure as with "When I Was a Newborn Baby."**

5. **Have the students verify and modify their stories.**

   Have them
   - Take the stories home for family members and friends to verify.
   - Bring back suggested additions and other changes.

6. **Discuss the students' stories.**

   Help the students make generalizations about their stories by asking such questions as
   - What are the things that most of us thought happened to us?
   - What are the things that were different?
   - What changes occurred as we grew older?

7. **Compare the development of a newborn baby, a toddler, and a preschooler with that of the pet mammal babies.**

   Ask such questions as
   - In what ways is our development similar to that of pet babies?
   - In what ways is our development different from that of pet babies?
   - What are the similarities and differences in what we learn compared with what young pets have to learn?

8. **Summarize the activity by having the students complete Student Page 4.3.10 OUR EARLY YEARS.**

EXTENSION

- Have the students make a display of the lists of things that have to be done for humans at different stages of their development.

Name__________________________

Date__________________________

DASH

STUDENT PAGE 4.3.10 OUR EARLY YEARS

1. List the things you think newborn babies can do, can't do, and can learn.

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2. List the things you think a toddler can do, can't do, and can learn.

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Name ______________________

3. **List the things you think a preschoolers can do, can't do, and can learn.**

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4. **How are young children similar to and different from young animal pets?**

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ACTIVITY 4.3.11 THE FIRST GRADE CHILD

OBJECTIVES

The students
- Interview first graders.
- Report on their interviews.

BACKGROUND

This is part of the series on the life cycle of mammals. It should follow 4.3.10 OUR EARLY YEARS and precede 4.3.13 HUMAN GROWTH AND DEVELOPMENT.

Coordinating Cross-Grade Interviews

In THE FIRST GRADE CHILD the students observe younger children. This is another venture into finding ways to understand the past. Here the students use interviews of first graders to learn about their own past. The intent of this activity is multiple. First, it gives further insights into the complexity of human development compared with that of animal pets. Second, it gives the students insight on how to work with siblings and younger students.

This activity will require coordination with a first grade teacher to find an acceptable interview time. If you plan to have fourth graders help first graders in a conservation activity, these interviews will provide an ideal way to introduce the classes. See Activity 4.9.2 RECYCLING PROJECT.

STUDENT ROLE

Interviewer

MATERIALS

Student Page 4.3.11 THE FIRST GRADE CHILD

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Help the students develop interview questions to ask the first graders.**

   Help them develop questions around such ideas as
   - Interests they may have in common.
   - What they are learning in class.
   - What they like about school.
   - What they can and can't do
   - What they would like to have help with.

2. **Help the students prepare to interview first graders and record what it is like to be a first grader. Have them use Student Page 4.3.11 THE FIRST GRADE CHILD.**

   Help them
   - Decide what to do to carry out the interview.
   - Decide whether they are going to interview individuals or small groups of first graders.
   - Set up contact with a first grade teacher.
   - Decide where the interviews are to take place.

3. **Have the students carry out the interviews.**

4. **Summarize the interviews.**

   Have the students report on and discuss their interviews. Help them include such ideas as
   - The common things that first graders said.
   - Some unusual things that first graders said.
   - The kind of things first graders have learned since preschool.
   - How the development between birth and the first grade of school of humans is similar to and different from the early development of young pets. (Get at how long we take to develop and how much more we have to learn.)
   - Things they have learned that might be of value in helping younger children.
   - How their interviews give insights into their own past.

5. **Help the class send a letter of thanks to the first graders.**

EXTENSIONS

Help the students

- Develop a story about being a first grader.
- Use the information gained in the interview as facts about the children in their stories.
- Share their stories with the first graders.
- Give the stories to the first graders as gifts.

Name____________________________

Date____________________________

STUDENT PAGE 4.3.11 THE FIRST GRADE CHILD

1. List the questions you want to ask a first grader when you have your interview.

2. List a first grader's answers to your questions.

ACTIVITY 4.3.12
GROWTH, DEVELOPMENT, AND BEHAVIOR OF YOUNG PETS

OBJECTIVES

The students
- Mark their pets for observation.
- Observe the growth of their baby pets.
- Observe development of the motor skills of their baby pets.
- Observe how adult animals treat the baby pets.

BACKGROUND

This activity is part of the series on the life cycle of mammals. It should follow 4.3.11 THE FIRST GRADE CHILD and precede 4.3.13 HUMAN GROWTH AND DEVELOPMENT.

The students again make a list of questions they have about the growth and development of mammals and then look for answers.

Handling Baby Pets

Weighing and measuring the baby pets should be a daily or every-other-day activity. The length of the pets should also be measured. The students should wash, rinse, and dry their hands thoroughly before and after handling the babies because mother animals may react negatively to human scent left on their young. Babies should not be handled until the mother is willing.

STUDENT ROLE

Developmental biologist

MATERIALS

Mother pet mammal
Baby pet mammals
Balances
Tape measures
Food coloring
Student Page 4.3.12 GROWTH, DEVELOPMENT, AND BEHAVIOR OF YOUNG PETS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Help the students ask additional questions about the development and behavior of their baby pets. Have them predict the answers they will find. Have them use Student Page 4.3.12 GROWTH, DEVELOPMENT, AND BEHAVIOR OF YOUNG PETS for recording.**

   Help the students include such questions as
   - How long before the baby pets open their eyes?
   - Do they all open their eyes at the same time?
   - Do they have fur?
   - How long before they start to get fur?
   - Do they all get fur at the same time?
   - How soon before they start to walk?
   - Do they all walk at the same time?
   - How much do the babies grow? In a week? In a day? (Weight and length data should be taken and graphed.)
   - Do all the babies grow the same amount in the same period?
   - Do the babies play? If so, how?
   - How soon before they leave the nest?
   - Do all the babies leave the nest at the same time?
   - Do some or all the babies return to the nest?
   - When do the babies start to eat outside the nest?
   - How do they learn their way to the food container?
   - When do the babies start to drink outside the nest?
   - How do they learn how to make their way to the water?
   - How do other adult pets treat the babies at different stages of the babies' development?
   - When do the babies start to exercise?
   - How can we tell which babies are males and which are females?
   - How do the babies learn to clean themselves?
   - Do the babies lose their teeth and grow new ones as we do?
   - When does the mother start to wean her babies?
   - How does she wean them?

2. **Demonstrate the proper way to handle the babies and help the students mark them for identification.**

- Help the students find ways to mark the babies. (Dots of dark food coloring will usually last several days.)

3. **Help the students organize to answer questions about the babies' growth and development.**

   Help them
   - Select questions to be answered.
   - Decide who is to be responsible for different questions.

4. **Have the students observe the babies and record their observations.**

5. **Summarize the observations.**

   Have the students
   - Report the answers they found to their questions.
   - Discuss differences in observations and reconcile them when possible.

EXTENSION

- Have the students post growth and development charts for their baby animals.

Name________________________

Date_________________________

DASH

STUDENT PAGE 4.3.12 GROWTH, DEVELOPMENT, AND BEHAVIOR OF YOUNG PETS

1. Record your questions about the growth, development, and behavior of your young pets. Give your predictions of what you think you will find the answers to be. Record your observations of the animals and the answers you found to your questions.

QUESTIONS	PREDICTIONS	OBSERVATIONS	ANSWERS

10.26.94

The DASH Project, University of Hawaii, CRDG

Name ______________________

2. Collect data on two or more babies and record your data on the table below.

Name of baby	Type of Mammal	Date of Birth	Date Measured	Weight (g)	Body Length (cm)

Name ____________________

3. **Graph the growth of two or more babies.**

4. **Describe the similarities and differences in the babies' growth.**

ACTIVITY 4.3.13 HUMAN GROWTH AND DEVELOPMENT

OBJECTIVES

The students
- Bring in "secret" baby pictures.
- Hold a "Name That Baby" contest.
- Review the contest.
- Compare changes in animal babies with those of humans.

BACKGROUND

This activity is part of the series of the life cycle of mammals. It can be done anytime after 4.3.12 GROWTH, DEVELOPMENT, AND BEHAVIOR OF YOUNG PETS is completed.

Keeping Identity Secret

From kindergarten DASH students have been collecting data on their personal growth. However, they have not kept a record of how their physical appearance has changed. In this activity they bring to class baby pictures enclosed in envelopes so that no one will be able to see them. To keep track of the pictures you will probably want to have the students put their names on the outside of the envelopes. Then you can assign numbers to the envelopes and the pictures. A gallery of nameless, numbered pictures can be posted and a "Name That Baby" contest can be held to see who can identify the most pictures. For fun include one of your own baby pictures.

Analyzing Pictures

After the students have tried to identify whose picture is whose, have the most successful contestants tell how they made their identification. Help the students analyze the pictures to see how much they have changed since babyhood. Help them relate the changes in their appearance to the changes that took place in their baby pets.

STUDENT ROLE

Pediatrician

MATERIALS

Baby pictures

Student Pages:
4.3.12 GROWTH, DEVELOPMENT, AND BEHAVIOR OF YOUNG PETS
4.3.13 HUMAN GROWTH AND DEVELOPMENT

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Have the students bring in "secret" pictures of themselves as babies.**

   Have them
   - Bring in pictures of themselves that no one in the class has seen.
   - Bring the pictures in sealed envelopes with their names on the outside.

2. **Make a gallery of faces using the baby pictures.**

   Organize the gallery. Identify each picture with a number. Include your own baby picture.

3. **Hold a "Name That Baby" contest.**

   Have the students match the pictures of babies with individuals in the class.

4. **Review the contest with the class.**

   Ask such questions as
   - Who matched the most pictures correctly?
   - How did you make your identification?
   - What did you look for?
   - Who in the class has changed the least?
   - What can we say about changes in appearance over time?
   - How do we change? (Help the students list such things as size, weight, body proportions, physical features.)

5. **Compare appearance changes in humans with those in the pet babies.**

Ask such questions as
- What are the differences in appearance that occur in the lifetime of a pet and the lifetime of a human?
- What are the similarities?

EXTENSION

- Have the students compare themselves with pictures of other family members at the same age.

Name_______________________

Date_______________________

STUDENT PAGE 4.3.13
HUMAN GROWTH AND DEVELOPMENT

1. List some ways your classmates have changed since birth.

2. How are human growth and development similar to your pets'? How are they different?

ACTIVITY 4.3.14 CHANGING DIMENSIONS

OBJECTIVES

The students
- Use imprints of their hands and feet and weight and length from their birth records.
- Collect, graph, and analyze class data on growth.
- Compare their own growth with that of their pets.

BACKGROUND

This activity is part of the series on the life cycle of mammals. It should follow Activities 4.6.1 GROWTH CHART AND AREA MEASUREMENT and 4.3.13 HUMAN GROWTH AND DEVELOPMENT.

In CHANGING DIMENSIONS the students analyze their growth data since birth. They usually find that they have all increased in size, but there are individual differences in how much and when increases took place. They also usually find that many of the girls have been bigger than the boys for much of the time, though this is beginning to change.

Organizing Data

Because some students will be embarrassingly aware of size difference, it is important to use group data as much as possible. This has the added advantage of providing information for students who have no previous DASH or birth records.

- Have the students invent a way to keep data anonymous; for example, information can be put on a data sheet by assigned numbers drawn from a hat. Point out that such techniques are used in many survey situations.
- Have the students graph the class data. If they understand averaging, have them average the data. This can be speeded up by using calculators. If the students do not understand averaging, the data points can be generalized to represent the average.
- Have the students collect information on females and males separately to show differences in growth patterns.

STUDENT ROLE

Pediatrician

MATERIALS

Tracing paper
Graph paper
Information from birth records
Individual Growth Charts
Individual Tooth Charts
Student Page 4.3.14 HOW I'VE GROWN

PRODUCTS

Class Growth Graphs
Completed Student Pages

PROCEDURES

1. **Have the students bring in their birth statistics. Demonstrate how to trace hand and foot imprints found on birth records by using tracing paper or by holding the paper to be traced up to a window.**

   Have the students bring in
   - Hand and foot tracings from birth or other records.
   - Weight and length measurements from birth or other records.

2. **Have the students record their yearly height, weight, and hand and foot area measurements on Student Page 4.3.14 HOW I'VE GROWN.**

3. **Have the students graph their growth and development data since birth.**

   Have them
   - Graph individual hand and foot area, height, and weight data from birth.
   - Make class graphs of the same data. Use average data for each year. Calculators will help the process.

4. **Review the raw data and class graphs.**

Ask such questions about height of males and females as

- On average, how much has height increased since birth?
- What happened to height between measurements?
- Did anyone's height change the same amount as someone else's?
- Did anyone's height stay the same?

Ask such questions about weight as

- On average, how much has weight increased since birth?
- What happened to weight between measurements?
- Did anyone's weight change the same amount as someone else's?
- Did anyone's weight stay the same?
- What can we say about the way weight has changed? (Work toward the idea that weight usually increases and again there are great individual differences in timing and amount of growth.)

Ask such questions about hand size for males and females as

- On average, how much has hand size increased since birth?
- What happened to hand size between measurements?
- Did anyone's hand size change the same amount as someone else's?
- Did anyone's hand size stay the same?
- What can we say about the way hand size has changed? (Work toward the idea that hand size usually increases and that, as with weight and height, there are great individual differences in timing and amount of growth.)

Ask such questions about foot size for males and females as

- How much has foot size increased since birth?
- What happened to foot size between measurements?
- Did anyone's foot size change the same amount as someone else's?
- Did anyone's foot size stay the same?
- What can we say about the way foot size has changed? (Work toward the idea that foot size usually increases and there are wide individual differences in growth.)
- What differences, if any, are there between the growth curves of females and males?

5. **Have the students compare their growth data with their growing pets'.**

Ask such questions as

- How is the way we grow similar to the way that our pets grow?
- How is the way we grow different from the way our pets grow?

- How long does it take a small animal to grow into an adult?
- Do these pets grow all their lives? (Some fish and reptiles grow all their lives while mammals tend to stop growing after a certain time.)
- Do you think we grow all of our lives? What evidence do you have for your answer?
- How might you test your answer?

EXTENSIONS

Have the students

- Make a home survey of siblings and adults to find out whether they have stopped growing.
- Project how tall, heavy, and so forth the students think they will be at age 20.

Name____________________________

Date____________________________

STUDENT PAGE 4.3.14 HOW I'VE GROWN

1. On the grid below trace the outlines of your baby handprint and footprint.

2. Calculate the area of your baby hand and foot.

Area of hand:	Area of foot:

3. Record your weight and length at birth.

Weight at birth:	Length at birth:

Name ______________________

4. Using your DASH Growth Charts and birth information, find your dimensions and record them below.

MEASUREMENT	BABY	K	1	2	3	4
Weight						
Height						
Hand Area						
Foot Area						

5. Graph the class growth data for each of the measurements above. Use the attached graph paper.

6. Describe your growth.

Name ________________________

ACTIVITY 4.3.15 EXTERNAL ANATOMY OF FISH

OBJECTIVES

- Carry out a directed anatomy investigation.
- Draw and label the parts of a fish.

BACKGROUND

This activity is part of the anatomy series. It should be done along with Activity 4.3.16 CLEANING FISH: INTERNAL ANATOMY or precede it.

EXTERNAL ANATOMY OF FISH can be carried out by simply observing live fish. However, non-living fish can be observed in greater detail. If the internal and external anatomy are to be done at the same time, one and a half to two hours of continuous time will be needed. Live fish should be observed to verify the function of the external structures. This can be done anytime after this activity is completed.

External Structures

Below are the external structures of the fish and their functions.

Table 4.3.15 External organs of fish and their functions

ORGAN	FUNCTION
Mouth	Capture of food
Nostrils	Sensing chemicals in water
Gill covering	Protects exit for water
Anus	Exit for waste
Urogenital opening	Exit for urine, sperm, and egg
Eye	Seeing
Pectoral fins	Swimming
Anal fin	Swimming
Tail fin	Swimming
Dorsal fins	Swimming
Lateral line	Sensing pressure

Important external structures of the fish are the external body openings—the mouth; opening at the edge of the gill covering; anus; urogenital opening right beyond the anus for eggs, sperm, and urine; eyes; and nostrils (the fish's equivalent of our nose). There are the pectoral fins, which correspond to our arms; the pelvic fins, which correspond to our legs; the anal fins, which are found beyond the anus; the tail fins, technically called the caudal fins; and the back or dorsal fins. Down the side of the fish is a line of special scales that are used in sensing pressure. This line is called the **lateral line.** See Figure 4.3.15.

STUDENT ROLES

Anatomist
Ichthyologist

MATERIALS

Fish in aquarium
Fish for cleaning
Aprons
Newspaper
Soap and water
Student Page 4.3.15 EXTERNAL ANATOMY OF A FISH

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Develop a working definition of the term "anatomy."**

   Develop the idea that "anatomy" refers to the parts of plants and animals. **Anatomy** is the science of the structure or way the parts of plants and animals fit together.

2. **Let the students lead a discussion of the external parts of the fish.**

   Be sure they
   - List the external anatomic parts they expect to find on a fish.
   - Explain why they think each part will be present.
   - Tell what they think the function of each part might be.
   - List questions they would like answered in studying the external anatomy of a fish.

3. **Help the students examine the external anatomy of a live and a dead fish. Have them observe live fish in an aquarium. Dead fish can be laid out on newspaper and observed closely.**

   Have the students
   - Wear aprons if they are examining a dead fish.
   - Try to locate all the parts they have listed.
   - Identify any other parts they find that are not listed.
   - Seek answers to their own questions.
   - Wash their hands after handling a dead fish.

4. **Have the students draw a fish and label the parts. Have them use the part names listed in Student Page 4.3.15 EXTERNAL ANATOMY OF A FISH.**

   Help the students
   - Identify the parts as they grapple with the names.
   - List the possible functions of the parts.

5. **Review the investigation with the students before the fish are put away.**

   Ask such questions as
   - Did everyone find the same parts? (Go over all parts.)
   - Did anyone find parts that were not listed? What were they?
   - What do you think the functions of all these parts are?
   - How can we find out?

6. **Have the students observe fish in an aquarium to verify the function of all the body parts.**

7. **Have the students extend their observations of fish.**

   Ask such questions as
   - What parts of the fish correspond to our body parts?
   - If the fish were to attempt to come on land, what body parts might it use to maneuver? (Help the students locate the pectoral fins.)
   - How much do fish see? Why? (Have the students draw the head of the fish with its eyes situated on the side. They can observe that the fish looks out into two hemispheres that include almost all

the things around them. Compare this with our field of vision. We see only half of what is around us—those things in front of us.)

- What advantages does the fish's visual system have over ours? (Fish can see all around themselves.)
- What advantages does our visual system have over the fish's? (We can see in three dimensions.)
- Why is it difficult to approach a pond without frightening the fish into hiding? (Because they can see so well.)

EXTENSION

- Have the students make a wall chart showing the external anatomy of a fish.

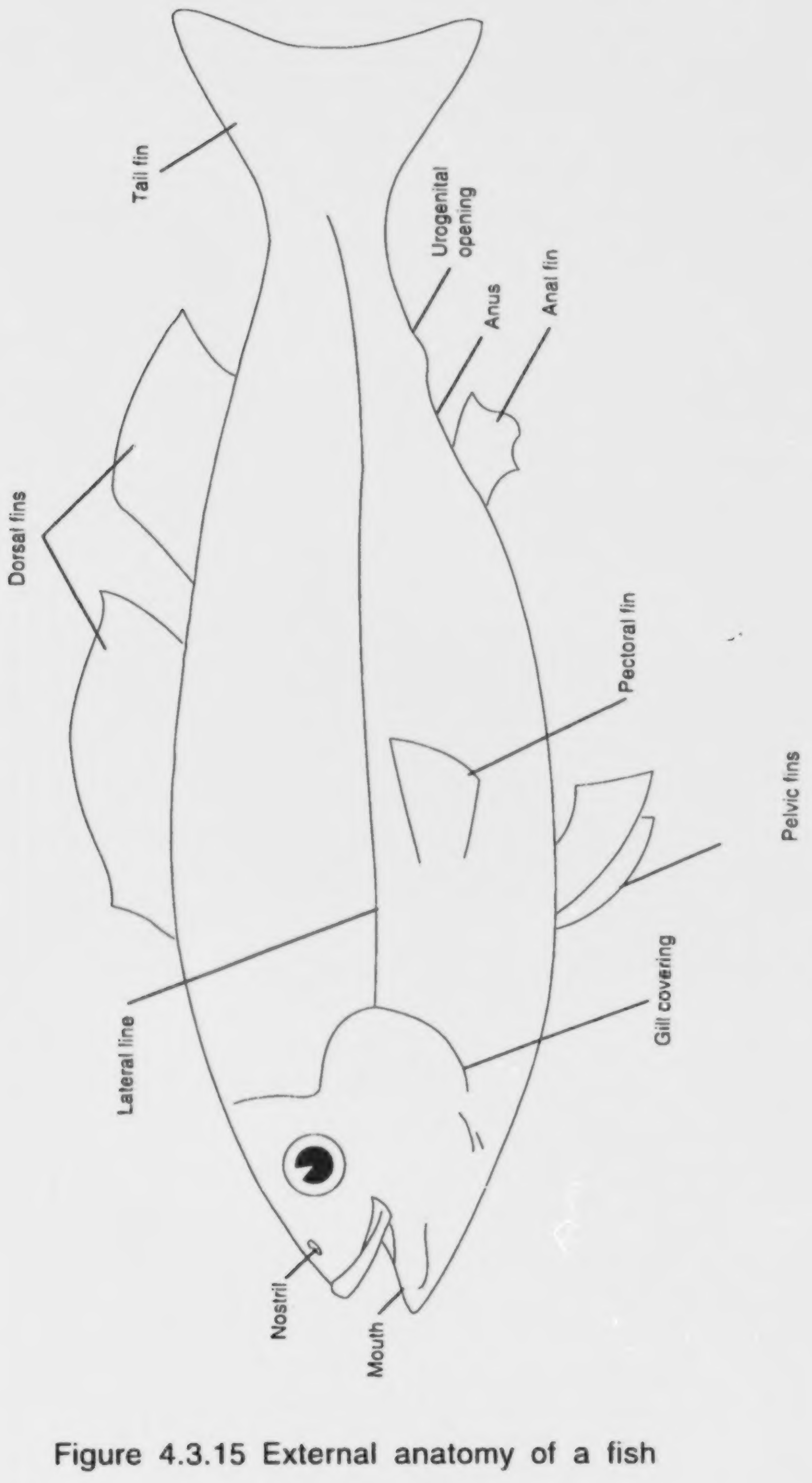

Tail fin
Urogenital opening
Anus
Anal fin
Dorsal fins
Pectoral fin
Pelvic fins
Lateral line
Gill covering
Nostril
Mouth

Figure 4.3.15 External anatomy of a fish

Name__________________________

Date___________________________

STUDENT PAGE 4.3.15 EXTERNAL ANATOMY OF A FISH

1. Draw a fish and label the structures listed in the table in Item 2.

Name ____________________

2. **Complete the table below by filling in the functions of the listed structures.**

STRUCTURE	FUNCTION
MOUTH	
NOSTRILS	
GILL COVERING	
ANUS	
UROGENITAL OPENING	
EYE	
PECTORAL FINS	
PELVIC FINS	
ANAL FIN	
TAIL FIN	
DORSAL FIN	

ACTIVITY 4.3.16 CLEANING FISH: INTERNAL ANATOMY

OBJECTIVES

The students
- Clean fish for eating.
- Carry out a directed internal anatomy investigation.
- Draw and label the internal organs of a fish.

BACKGROUND

This is part of the anatomy and the reproduction series. It should follow Activity 4.3.15 EXTERNAL ANATOMY OF FISH and precede 4.3.17 FISH REPRODUCTION.

In CLEANING FISH: INTERNAL ANATOMY the students clean fish that are to be either cooked or preserved. See Activity 4.5.6 PRESERVING FOODS. There is a philosophical issue involved here: Animals need not be sacrificed for dissection when they are constantly being used as food sources. By going over anatomy when animals are being prepared for food, the students can gain a great deal of first-hand information about the structure and location of organs. Some teachers may wish to use fresh road kill to investigate the anatomy of snakes, birds, rodents, and other mammals.

Success in finding organs depends on the size and freshness of the fish. A fresh, chilled whole fish weighing one pound or more is best. The location of organs will vary from species to species. See Figure 4.3.16.

Using Outside Resource People

It may be helpful to ask for parental assistance with this activity, particularly if you have not cleaned a fish before.

Protective Work Surface

Newspapers make a good covering for tables. Entrails removed from the fish can be wrapped and sent to the third grade compost pile.

Opening the Fish

You will probably want to do the opening of the fish for the students. Insert a sharp knife in the anus and make a shallow cut along the belly to the area right below the gill opening. Once this is done, turn the fish over to the students. Have them open the body and identify as many organs as possible without removing them. Have them carefully tease the organs away from the body with their fingers.

Organs and Their Functions

Listed below are the principal internal organs of fish and their functions. Do not be concerned if the students do not find all the body organs. This is a first exploratory experience.

Table 4.3.16 Internal organs of fish and their functions

ORGAN	FUNCTION
Tongue	Moving food
Gills	Breathing
Stomach	Digestion
Intestine	Digestion
Pyloric caeca	Produce digestive juices
Anus	Exit for solid waste
Kidneys	Produce urine
Gonads (testes, ovaries)	Produce eggs or sperm
Air bladder	Adjusts floating and sinking
Heart	Circulation of blood
Liver	Cleans blood
Brain	Runs body
Urogenital opening	Exit for urine, eggs, and sperm

Heart and Liver

The heart and liver are found right below the gills. Cut carefully so they are not injured.

Brain

The brain is in the front part of the head. You will need to cut through the bone of the head to get at it.

Eye

The eye can be removed and opened to reveal a round lens.

Sexing Fish

If the fish is about to reproduce, the ovary will be a sac, usually filled with yellow to orange eggs. In some fish they are about pinpoint size (guppy); in others they are as large as pencil erasers (salmon). The testis of the male will be a gray sac. When fish are not reproducing, the ovaries and testes may be difficult to find.

Things to Note

- The mouth has two exits—one for water through the gills, one for food through the stomach.
- There are several gills on either side of the head.
- The black kidney is right against the backbone.
- The stomach can be opened to see what the fish has eaten.
- The air bladder will look like a cellophane sac.

STUDENT ROLES

Fisher
Ichthyologist
Anatomist

MATERIALS

Fish
Knives
Aprons
Soap and water
Newspapers
Student Page 4.3.16 CLEANING FISH: INTERNAL ANATOMY

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Explain that the class is going to clean fish for cooking or preserving. Have the students discuss the organs they would expect to find in a fish.**

   Have them
   - List the organs they expect to find.
   - Explain why they think each organ will be present.
   - Tell what they think may be the function of these different organs.
   - List questions they would like answered when observing fish entrails.

2. **Help the students clean a fish. Clean a fish along with the them, pointing out its internal anatomy. Have the students look in their fish for the organs you find.**

   Have the students
   - Wear aprons.
   - Wash their hands before and after handling the fish.
   - Scale the fish if required for cooking.
   - Find each of the organs identified by the person cleaning the fish.
   - Place a paper label on each organ.
   - Compare labels and make corrections where needed.
   - Seek answers to their own questions.

3. **Have the students draw and label the internal organs of the fish.**

   Have them use Student Page 4.3.16 CLEANING FISH: INTERNAL ANATOMY.

4. **Have the students remove the entrails and prepare the fish for cooking or preserving.**

5. **Review the activity after the fish investigations have been completed. Go over the students' anatomical findings. This need not be done the same day as the investigations.**

   Ask such questions as
   - What organs of the fish's anatomy seem to be involved in processing food? (Get agreement on the mouth, tongue, teeth, stomach, intestine, and anus.)
   - In what order did these organs appear in the fish?
   - Where were the sex organs in the body of the fish?
   - How might eggs or milt (sperm) leave the body of the fish? (Point out a second opening behind the anus, if there is one. This would be the urogenital opening. Some fish have only one opening.)
   - Where was the heart of the fish?
   - How was the heart connected to the rest of the body? (Only large blood vessels will be observable.)
   - Where were the kidneys of the fish? (Up against the backbone.)
   - Where were the gills of the fish?
   - How were the gills connected to the rest of the body? (The gills are attached to the floor and roof of the mouth.)

- What questions of your own did you investigate? What answers did you find?

EXTENSIONS

Have the students

- Make a wall chart of the internal anatomy of a fish.
- Investigate the anatomy of a chicken.
- Investigate the anatomy of a frog.

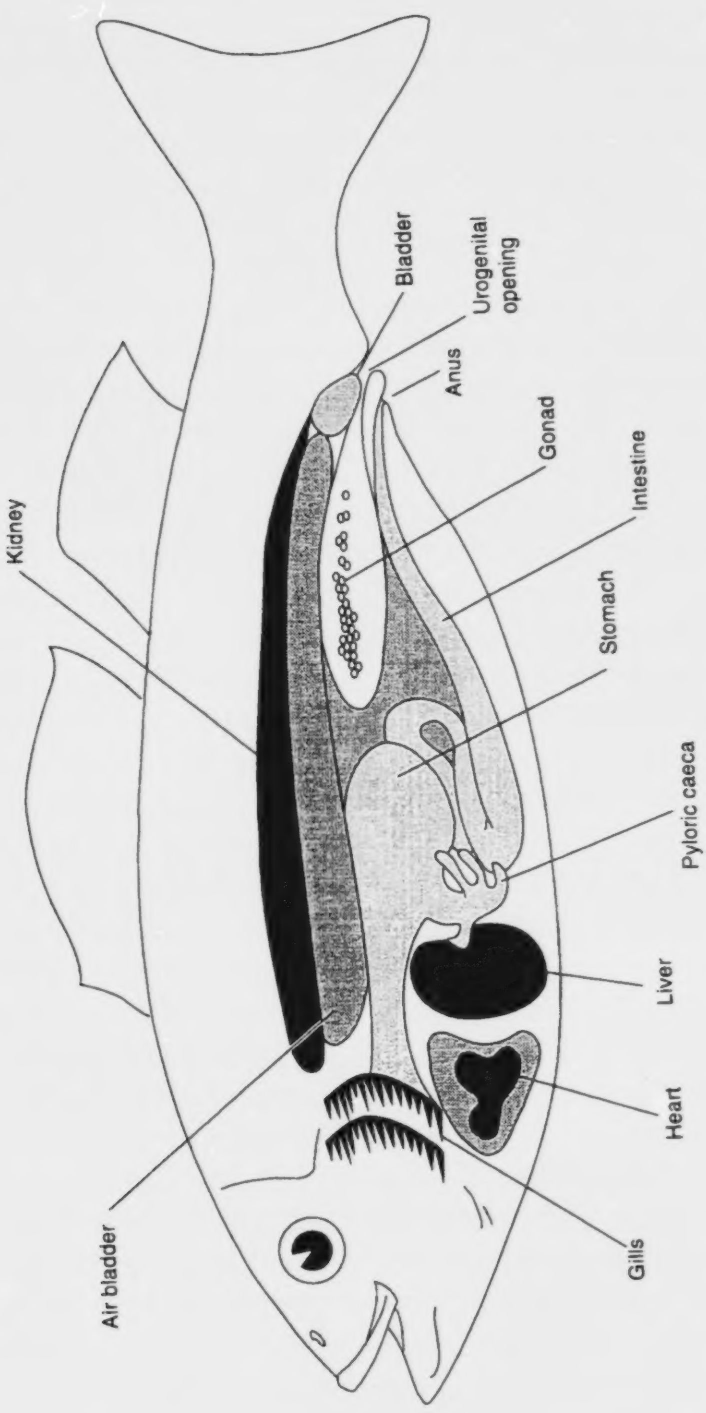

Kidney
Air bladder
Bladder
Urogenital opening
Anus
Gonad
Intestine
Stomach
Pyloric caeca
Liver
Heart
Gills

Figure 4.3.16 Internal anatomy of a fish

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.16
CLEANING FISH: INTERNAL ANATOMY

1. Draw the internal anatomy of a fish and label the organs listed in the table in Item 2.

Name ____________________

2. Complete the table below by listing the functions of the internal organs of a fish.

ORGAN	FUNCTION
TONGUE	
GILLS	
STOMACH	
INTESTINE	
PYLORIC CAECA	
ANUS	
KIDNEYS	
GONADS (TESTES, OVARIES)	
AIR BLADDER	
HEART	
LIVER	
BRAIN	
UROGENITAL OPENING	

ACTIVITY 4.3.17 FISH REPRODUCTION

OBJECTIVES

The students
- Review the term "reproductive system" and make a concept map about it.
- Review their experience with fish and frog reproduction.
- Review their drawings of fish anatomy.
- See videotapes on fish reproduction.

BACKGROUND

This activity is part of the anatomy and the reproduction series. It should follow Activity 4.3.16 CLEANING FISH: INTERNAL ANATOMY and Activity 4.3.7 PAIRING PET MAMMALS. In FISH REPRODUCTION the students put together what they know about anatomy and reproduction.

Previous Experience

From previous DASH experience the students should have some understanding that
- Eggs are produced in the ovaries of female animals and the female parts of plants.
- Sperm are produced in the testes of male animals and the anthers of flowering plants.
- Egg and sperm unite to form new organisms.
- Fish and most frogs deposit their eggs in water.
- Chicks, frogs, fish, and insects develop in eggs outside the female's body.
- Mammals develop inside the female's body.
- Mammals do not naturally reproduce unless male and females are together. (The students may have observed animals mating.)
- Fish and frogs do not naturally reproduce unless the male and female are in the same area.

Videotapes

In FISH REPRODUCTION the students view videotapes to reinforce the following concepts:
- The male produces sperm.
- Testes are the organs of sperm generation.
- Egg and sperm must unite to start reproduction.
- Fish and most frogs discharge eggs and sperm into water.

STUDENT ROLES

Anatomist
Biologist

MATERIALS

Videotapes on fish reproduction
Student Pages 4.3.15 EXTERNAL ANATOMY OF FISH
4.3.16 CLEANING FISH: INTERNAL ANATOMY
4.3.17 FISH REPRODUCTION

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Make a concept map of the term "reproductive system" with the students.**

   Using the map, help the students
   - Define the concept of a system. (Work to the idea of a set of interconnected parts that together have a common function, purpose, or characteristic action.)
   - Name the body parts involved in reproduction.
   - Indicate which parts are associated with males and which with females.

2. **Review the students' experience with reproduction of fish and frogs.**

   Ask such questions as
   - Where do fish reproduce?
   - How do they reproduce? (Work toward the fact that they deposit their eggs in water.)
   - What does the female fish do? (Carries and deposits eggs.)
   - Can female fish reproduce without males? (If no one can answer the question, put it in the Wonder and Discover Book. Eggs must be fertilized before reproduction can take place.)

- What does the male fish do? (If no one can answer the question, put it in the in Wonder and Discover Book. The male fish produces sperm and releases it in the water to fertilize the eggs.)
- Where do frogs reproduce?
- How do they reproduce? (Help the students recall the DASH 3 work on frogs. Work toward the fact that most frogs lay eggs in water.)
- Can the female frog reproduce without a male? (If unknown, put the question in the Wonder and Discover Book. As with fish, sperm and egg are both needed.)
- What does the male do? (If unknown, put the question in the Wonder and Discover Book. As with fish, sperm are produced by the male.)

3. **Review the students' drawings of fish anatomy. Refer to Student Pages 4.3.15 EXTERNAL ANATOMY OF FISH and 4.3.16 CLEANING FISH: INTERNAL ANATOMY.**

   Ask such questions as
   - Where are the eggs produced in fish? (In the ovaries.)
   - How can the eggs get out of the body? (Through the urogenital opening.)
   - Where are the testes in fish?
   - What do the testes produce? (You may have to tell the students that testes produce sperm, and in fish the cloud of sperm released in the water is called **milt**.)

4. **Show videotapes on fish reproduction to reinforce previous answers and to provide new information where needed.**

5. **Review the videotapes on fish reproduction. Have the students lead a discussion of frog and fish reproduction and summarize it on Student Page 4.3.17 FISH REPRODUCTION.**

   Be sure they include
   - The environment in which reproduction takes place.
   - The organs involved.
   - Products of the reproductive organs (eggs and sperm).
   - Methods of uniting sperm and egg.
   - Identification of the process as sexual reproduction which involves members of opposite sexes.

6. **Have the students give working definitions of terms used in describing reproduction and record them in the Working Dictionary.**

   Be sure they include such terms as
   - Ovary.
   - Egg.
   - Testes.
   - Sperm.
   - Fertilization.
   - Reproduction.
   - Male.
   - Female.

EXTENSIONS

Show videotapes on
- Insect reproduction.
- Bird reproduction.
- Reptile reproduction.
- Frog reproduction.

Name________________________

Date________________________

DASH

STUDENT PAGE 4.3.17 FISH REPRODUCTION

Describe how fish reproduce.

ACTIVITY 4.3.18 MODELING OUR DIGESTIVE SYSTEM

OBJECTIVES

The students
- Identify the organs of the digestive system.
- Simulate the placement of digestive organs on a student model.
- Verify the location of digestive organs in the human torso.

BACKGROUND

This activity is part of the anatomy series. It should follow 4.3.16 CLEANING FISH: INTERNAL ANATOMY and precede 4.3.19 OUR DIGESTIVE SYSTEM IN TWO DIMENSIONS.

The Digestive Tract

Digestion of food takes place in the digestive tract, a continuous tube made up of distinctive parts called organs. The organs of the digestive tract are the esophagus, stomach, small intestine, large intestine, and the anus. Other associated organs are the liver, salivary glands, the pancreas and the glands in the tract lining that feed digestive juices into the tube. In the process of digestion, these juices change food into soluble substances or nutrients that can pass through the wall of the tract. When carried to the cells of our body, nutrients are the raw materials needed for activation, regulation, and fabrication.

The Models

In MODELING OUR DIGESTIVE SYSTEM the students familiarize themselves with the size, shape, and location of the main organs of the human digestive system. First, they predict the correct location of the digestive organs by pinning cutouts on a fellow student acting as a model. They then verify their predictions on a 3-dimensional model of the human torso. If a life-sized torso is not available, smaller models or charts can be used.

Comparing Human and Fish Digestive Tracts

Finally, the students compare the human and fish digestive tracts. These systems are quite similar. They are both tubes with their parts in the same sequence. Some differences are given below.
- Fish have teeth shaped to capture and tear food. We have teeth shaped to tear and grind food.
- Fish take water carrying dissolved gases into their mouth and pass it over their gills where respiration occurs. Oxygen enters and carbon

dioxide leaves through the gills. We humans breathe air through our nose and mouth. Our esophagus is a common food and gas tube with a branching tube for the passage of air into the lungs where respiration occurs.
- Fish do not have the large intestine that we have. Being land animals, we must conserve water and remove water from the waste of the digestive tract. This is done in the large intestine. Fish are bathed in water and do not need to conserve the water in their waste.

STUDENT ROLES

Physiologist
Medical doctor

MATERIALS

Pencil
Scissors, one set per group
Crayons or marking pens, one set per group
Tape or safety pins
Three-dimensional model of the human torso or diagrams of the digestive tract
Student Page 4.3.18 LIFE-SIZE DIAGRAMS OF DIGESTIVE ORGANS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Review the students' understanding of digestion.**

   Ask such questions as
   - What is the function of digestion in our body?
   - When does digestion take place?
   - Where does digestion take place?
   - How are the parts of our digestive system connected?

2. **Introduce the problem of locating the parts of the digestive system. Have the students work in groups of four to color and cut out the diagrams on Student Page 4.3.18 LIFE-SIZED DIAGRAMS OF DIGESTIVE ORGANS.**

Have the groups
- Decide who will be the model for their group.
- Predict the correct location of human digestive organs.
- Simulate the digestive tract by taping or pinning cutouts of the organs to the model's clothing.

3. **Organize a fashion show to display different ideas about the position of the digestive organs.**

   Have the students
   - Model their group's arrangement of organs for the class.
   - Vote to determine which group comes closest to the correct positions for the organs.

4. **Verify the correct location of the organs in the digestive system.**

   - Use a three-dimensional model of the human torso or diagrams of the digestive system to confirm organ locations.
   - Have the students adjust the cut-out organs on their live model.

5. **Compare the digestive tracts of humans and fish.**

   Ask such questions as
   - How are the digestive systems of fish and humans similar?
   - How are they different?
   - What characteristics of fish and humans might account for the differences and similarities?

EXTENSIONS

Have the students
- Mark the outline of a student's body on butcher paper and then tape cutouts of the digestive organs in appropriate places. Have them label the organs.

DASH

Name______________________________

Date______________________________

STUDENT PAGE 4.3.18
LIFE-SIZED DIAGRAMS OF DIGESTIVE ORGANS

Color, cut out the organs on the following pages, and attach them to the body of a human model. Simulate the natural location as closely as possible.

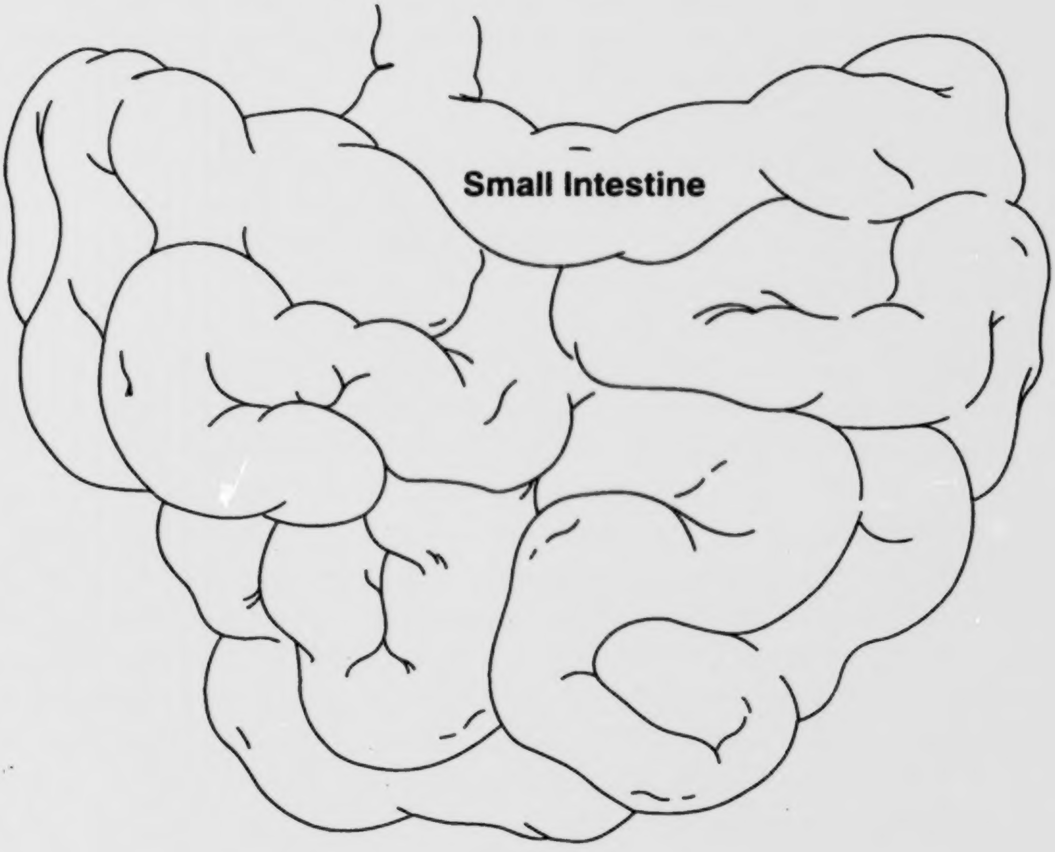


Figure SP 4.3.18(1) The small intestine

Name ______________________________

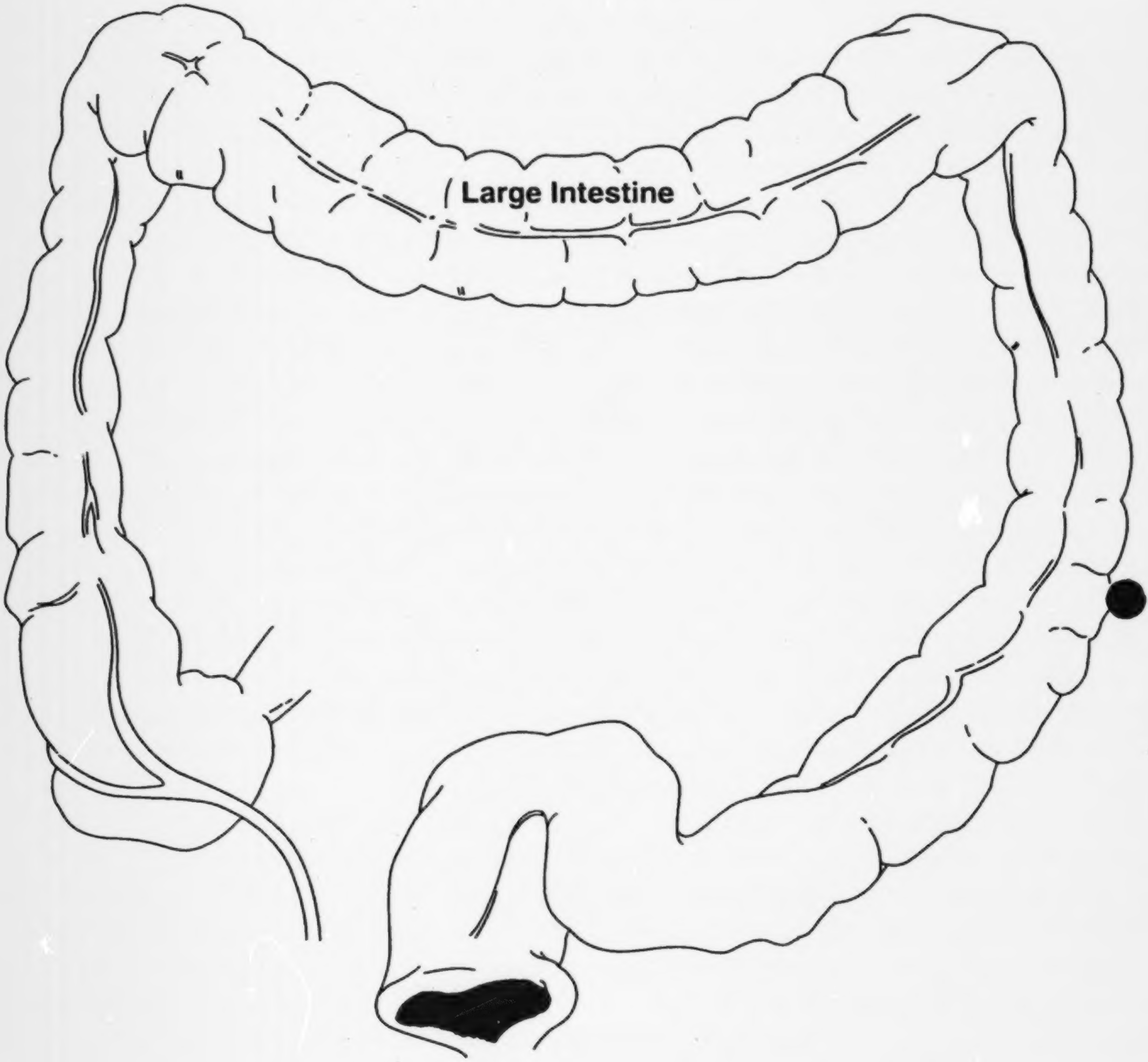

Large Intestine

Figure SP 4.3.18(2) The large intestine

Name ____________________

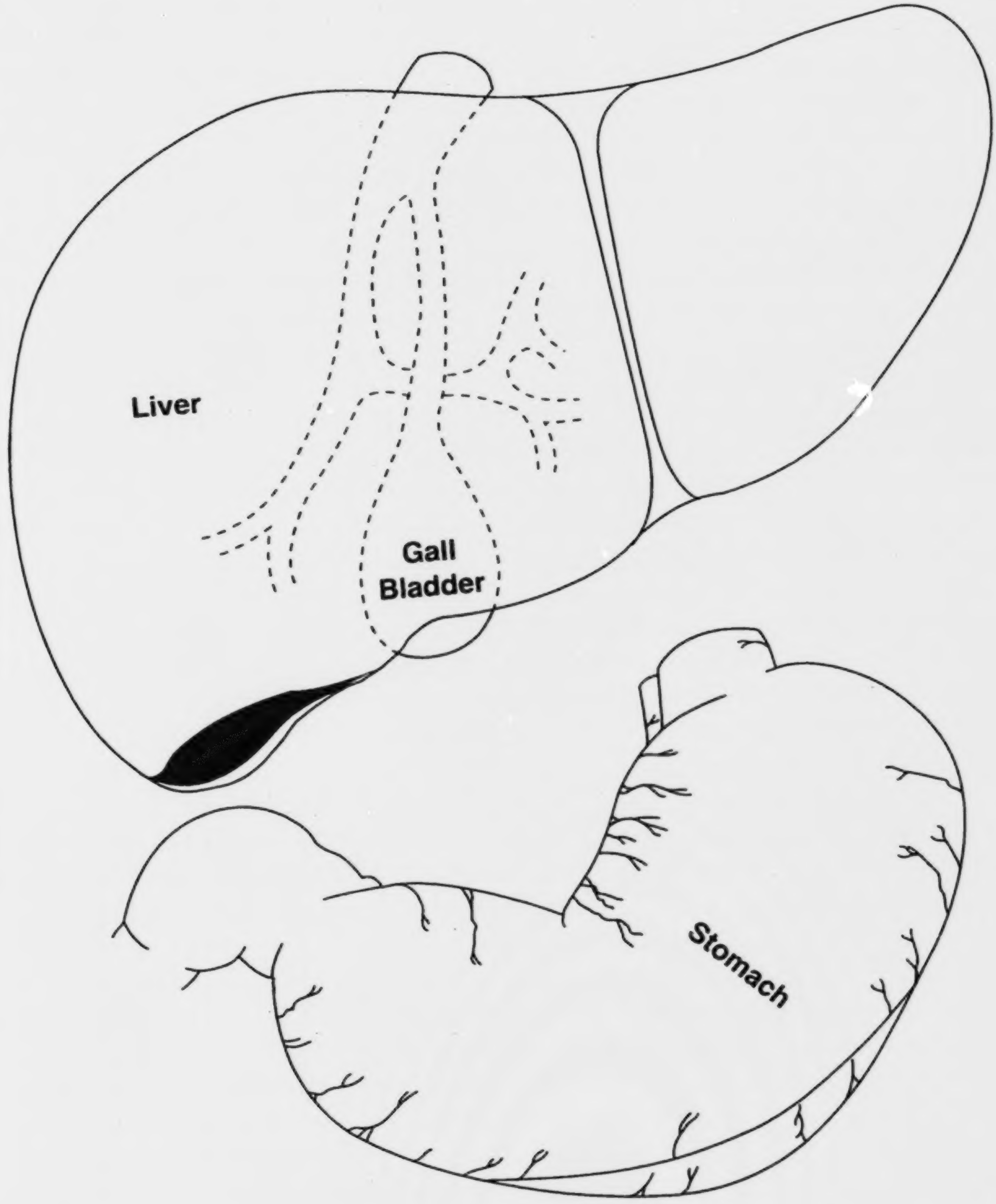

Liver
Gall Bladder
Stomach

Figure SP 4.3.18(3) The stomach, liver, and gall bladder

Name ______________________

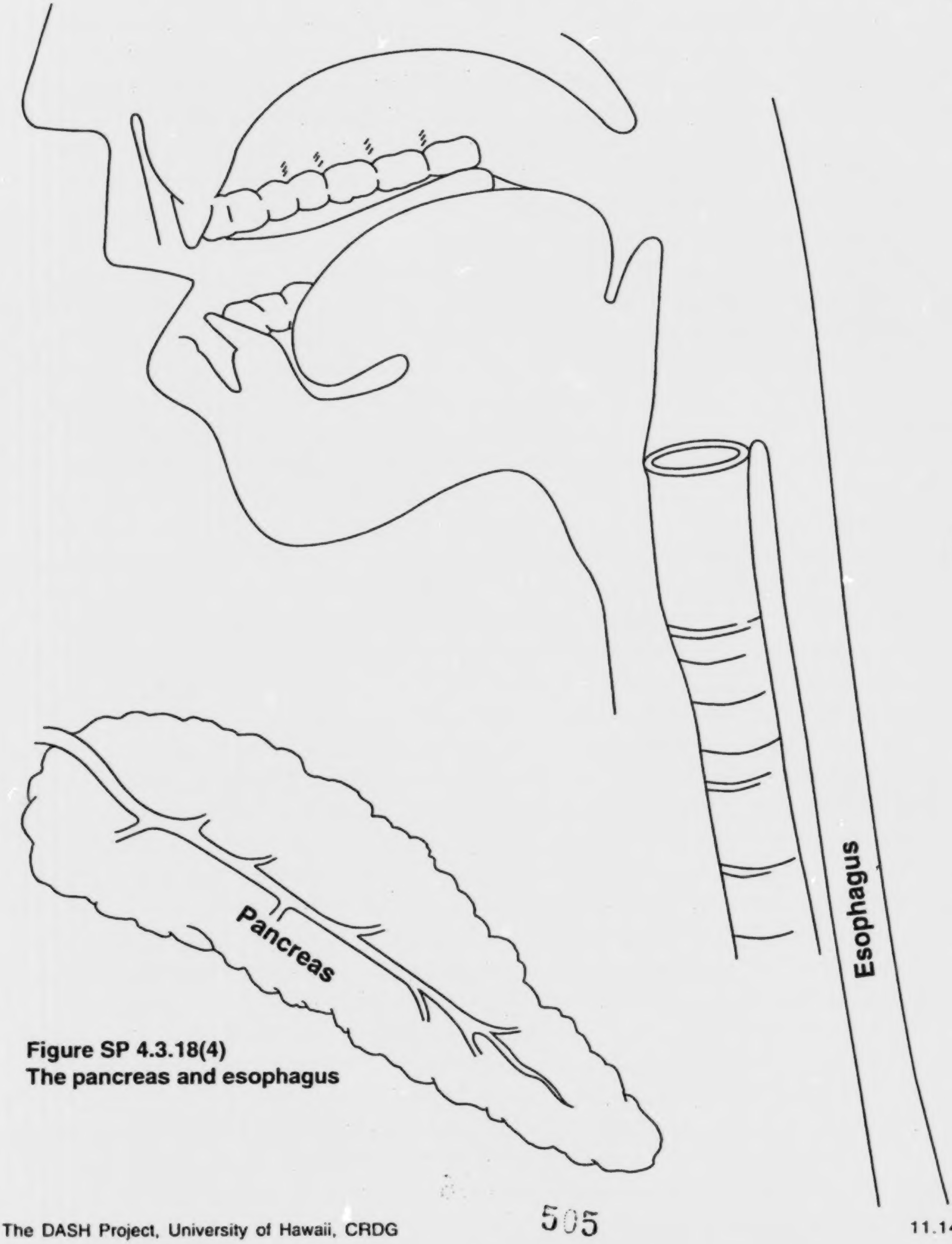

Pancreas
Esophagus

Figure SP 4.3.18(4)
The pancreas and esophagus

ACTIVITY 4.3.19
OUR DIGESTIVE SYSTEM IN TWO DIMENSIONS

OBJECTIVES

The students
- Review the digestive system.
- Locate parts of their digestive tract by chewing and swallowing.
- Identify parts of the human digestive system on a 2-dimensional drawing.

BACKGROUND

This activity is part of the anatomy series. It should follow Activity 4.3.18 MODELING OUR DIGESTIVE SYSTEM and precede Activity 4.3.20 DIGESTIVE, CIRCULATORY, AND RESPIRATORY SYSTEMS.

Organization

In OUR DIGESTIVE SYSTEM IN TWO DIMENSIONS the students get a feeling for the upper end of the digestive tract (the mouth, esophagus, and stomach) through a swallowing exercise. They then translate this knowledge into understanding the location of body organs on a torso. They also transform their 3-dimensional knowledge into a 2-dimensional diagram of the body by moving between living animals, models, and pictorials. See Figure 4.3.19.

STUDENT ROLES

Physiologist
Medical doctor

MATERIALS

Plastic-foam cups
Hot water at drinking temperature
Salt-free soda crackers
Mirror
Crayons or markers (1 set per group)
Three-dimensional model of the human torso
Two-dimensional diagram of the digestive system
Student Page 4.3.19 OUR DIGESTIVE SYSTEM IN TWO DIMENSIONS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Review the parts of the digestive tracts of fish and humans.**

   Ask such questions as
   - What parts make up the digestive tract of a fish? (Work to the mouth, stomach, intestine, and anus.)
   - What parts of the fish's digestive tract are different from those found in the human body? (Humans have the same parts as fish plus some others.)
   - What parts of the human digestive tract are different from those found in the fish? (Humans have a long esophagus and a colon or large intestine.)
   - What part of our own digestive system can we see? (The anus and parts of the mouth.)

2. **Have the students identify the functions of the upper end of their digestive tract.**

   Ask such questions as
   - Where does food enter our body to begin digestion? What happens next?
   - What parts of our mouth help digestion?
   - What happens to food when it is swallowed?
   - How does food get to our stomach?

3. **Give the students one salt-free soda cracker apiece. Have them describe each step from inserting the cracker into the mouth to taking a bite, chewing, and then swallowing.**

   Ask such questions as
   - How do you get the cracker into your mouth for chewing?
   - Is your tongue involved when you insert the cracker into your mouth?
   - How do you break off a piece of the cracker?
   - What parts of the mouth do we use to chew?
   - Why do we chew?
   - What parts of the mouth help to move the cracker around?

- What parts of the mouth help to move the cracker to the back of the mouth?
- What do you feel happening as you swallow?
- What is the name of the tube that food goes through when we swallow? (Esophagus)
- What prevents food from entering this tube while we chew?
- When you bend so that your head is below your waist, can you swallow the same way as when standing?
- What would happen if you tried swallowing while doing a headstand?

4. **Give the students another salt-free cracker. Have them chew it then leave it in their mouth for a few minutes.**

   Ask such questions as
   - What does the cracker taste like when first placed in your mouth? (Bland.)
   - What is the name of the liquid that collects in your mouth? (Saliva.)
   - What is its purpose? (Aids in the chemical digestion of food.)
   - What does the cracker taste like after being held in the mouth for a few minutes? (Probe for a slightly sweet taste due to the breakdown of starch into sugar.)

5. **Introduce the salivary glands. Point out that they are found under the tongue and back of the mouth.**

   Help the students
   - Find two small openings under the front of the tongue and two more openings near the back of the roof of the mouth. Have the students look for the openings in each other's mouth or in their own mouth using a mirror.
   - Note that saliva, the juice of salivary gland, starts to change starch to sugar. (Crackers have lots of starch.)

6. **Have the students drink small sips of hot water.**

   Ask such questions as
   - How do you think we swallow water?
   - Where does the hot water seem to go? (The students should be able to feel the water going down their esophagus into their stomach.)

7. **Have the students use Student Page 4.3.19 OUR DIGESTIVE SYSTEM IN TWO DIMENSIONS to label the parts of a 2-dimensional drawing of the human digestive tract.**

   Help them
   - Use a 3-dimensional model of the human torso or diagrams of the digestive tract.
   - Identify the mouth, throat, esophagus, stomach, small and large intestines, and anus.
   - Point out the salivary glands, liver, gall bladder, and pancreas.

8. **Discuss the limitations and advantages of using a live animal, a 3-dimensional model, and a 2-dimensional diagram in understanding the structure of the digestive tract.**

   Ask such questions as
   - What advantages might there be in using a live animal over using a model? (Seek such ideas as we could see how the parts really fit together and we could see the real parts and feel the connections as we did when we cleaned fish, and so forth.)
   - What disadvantages might there be in using a real animal? (Probe for such answers as one may have to kill an animal to examine the anatomy and the anatomy of a live animal is very complex and difficult to interpret.)
   - What advantages might there be in using a 3-dimensional model? (Try to get such answers as it's not necessary to kill an animal to look at the anatomy and a model is easy to take apart and reassemble and gives a reasonably realistic look at an animal's anatomy.)
   - What disadvantages might there be in using a 3-dimensional model? (Probe for such ideas as transporting a model is often very inconvenient, a model doesn't provide all the information that a live animal does, and 3-dimensional models are very expensive.)
   - What advantages might there be in using a 2-dimensional diagram? (Work toward such answers as 2-dimensional diagrams are easy to transport, are inexpensive, and are usually easy to get.)
   - What disadvantages might there be in using a 2-dimensional diagram? (Seek such ideas as it is hard to get a 3-dimensional sense of location and it is difficult to show the relative position of organs.)

EXTENSIONS

Have the students
- Post 2-dimensional diagrams next to a 3-dimensional model of the human torso.
- Show the relationship between the model of the human torso and the diagrams by using string to connect the corresponding body parts.

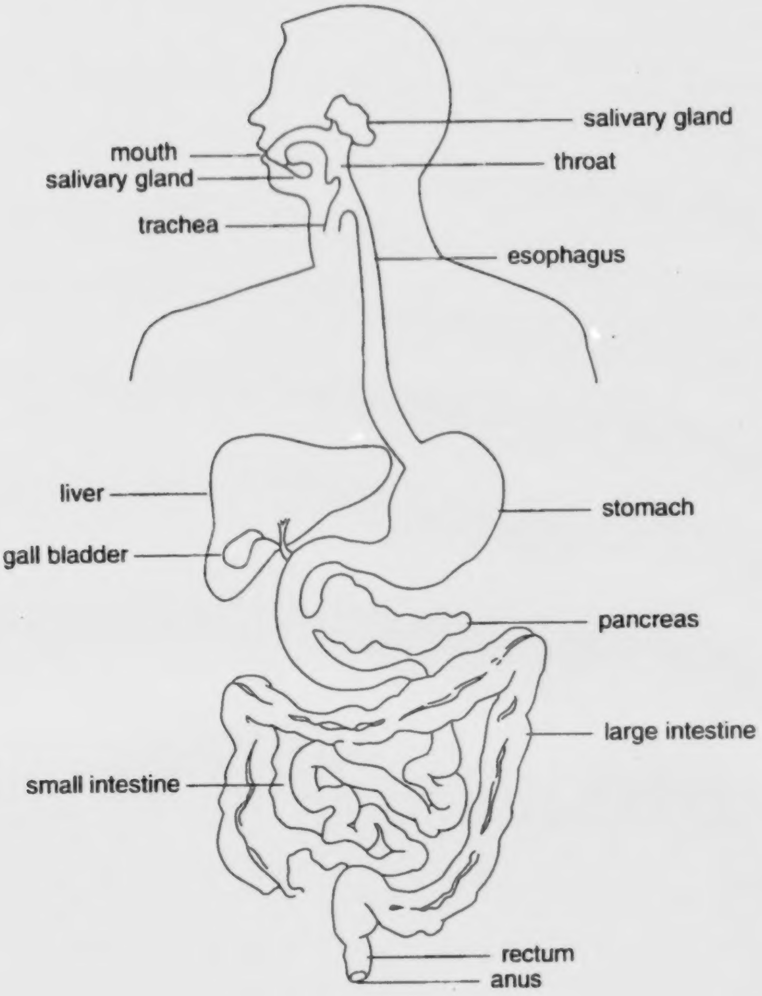

salivary gland
mouth
salivary gland
throat
trachea
esophagus
liver
stomach
gall bladder
pancreas
large intestine
small intestine
rectum
anus

Figure 4.3.19 Two-dimensional diagram of the human digestive system

Name__________________________

Date___________________________

DASH

STUDENT PAGE 4.3.19
OUR DIGESTIVE SYSTEM IN TWO DIMENSIONS

Label the parts of the human digestive tract.

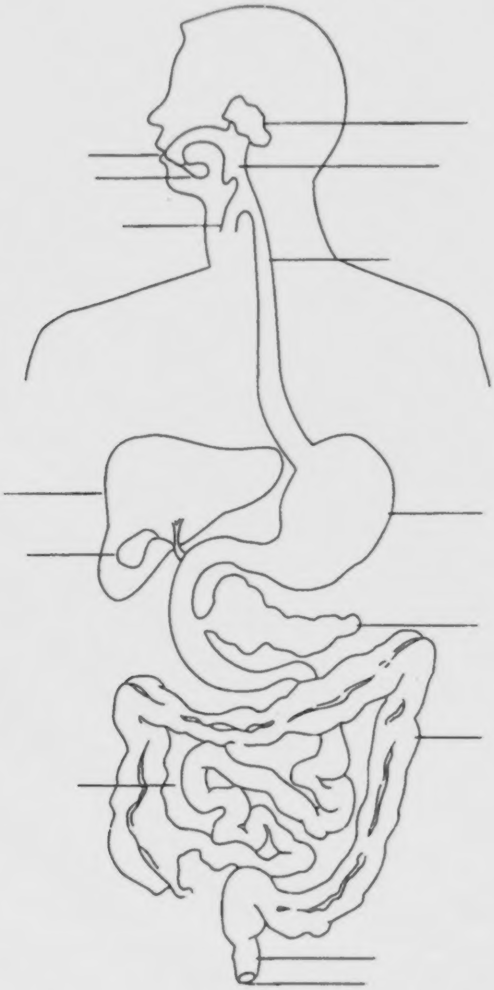


Figure SP 4.3.19 Two-dimensional diagram of the human digestive system

ACTIVITY 4.3.20
DIGESTIVE, CIRCULATORY, AND RESPIRATORY SYSTEMS

OBJECTIVES

The students
- Make a series of cross-sectional anatomic charts of the human body.
- Identify the organs of the human digestive, circulatory, and respiratory systems.

BACKGROUND

This activity is part of the anatomy series. It should follow Activity 4.3.19 OUR DIGESTIVE SYSTEM IN TWO DIMENSIONS and precede Activity 4.3.21 LENGTH OF THE DIGESTIVE TRACT.

In this investigation the three-dimensional human body is represented by three two-dimensional diagrams. Each of the diagrams shows a different view of a cross section of the body. The diagrams are designed to be assembled as a three-page booklet. As the pages of the booklet are turned, one sees ever deeper into the body cavity.

Student Materials

The student pages consist of three frames and a sheet of cutouts. The first student page contains diagrams of organs of the human digestive, circulatory, and respiratory systems that are to be cut out and attached to the three body frames. The students attach the chest, neck, and abdomen to FRAME 1: View of External Anatomy. They attach the liver, intestines, heart, lungs, and diaphragm to FRAME 2: Mid View of Internal Anatomy. Last, they attach the kidneys, stomach, trachea, and pancreas to FRAME 3: Deep View of Internal Anatomy.

In directing the activity, have available a model of the human torso or diagrams of the human chest and abdominal cavities. If Post-it glue is used, the students can remove and relocate the parts at will. Figures 4.3.20(1–6) show the cutouts in place.

STUDENT ROLES

Physiologist
Surgeon
Anatomist

MATERIALS

Scissors
Colored pencils, crayons
Post-it or other glue
Model of the human torso or diagrams of the chest and abdominal cavities
Student Pages 4.3.20A ANATOMIC PARTS
4.3.20B FRAME 1: VIEW OF EXTERNAL ANATOMY
4.3.20C FRAME 2: MID VIEW OF INTERNAL ANATOMY
4.3.20D FRAME 3: DEEP VIEW OF INTERNAL ANATOMY

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Give the students guidelines for assembling an anatomic booklet using Student Pages 4.3.20(A–D).**

   Have the students
   - Color the cutouts of anatomic parts if they wish.
   - Cut out the anatomic parts and attach them to the appropriate frames to show where the organs they represent appear in the human body.
   - Label the organs after they are attached.

2. **Summarize the activity.**

   Ask such questions as
   - What role does the circulatory system play in our body? (Help the students recall from DASH 3 that it carries nutrients, oxygen, and waste.)
   - What role does the respiratory system play in our body? (Help the students recall from DASH 3 that it provides oxygen to our body and carries out carbon dioxide.)
   - What role do the kidneys play in our body? (Help the students recall from DASH 3 that they carry waste out of our bodies in the form of urine.)

EXTENSION

- Have the students post the cross-sectional diagrams next to a model of the human torso and connect the anatomic parts with string.

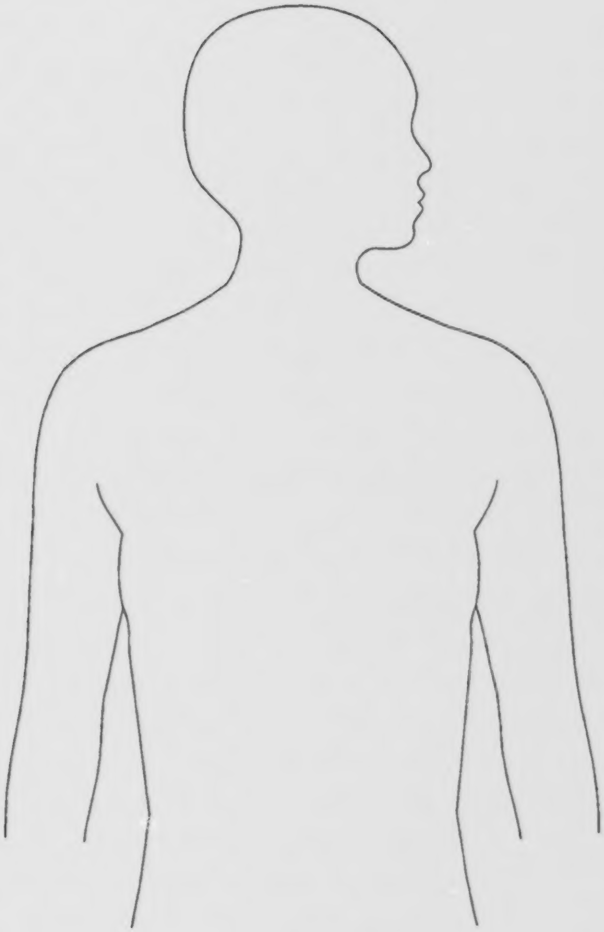
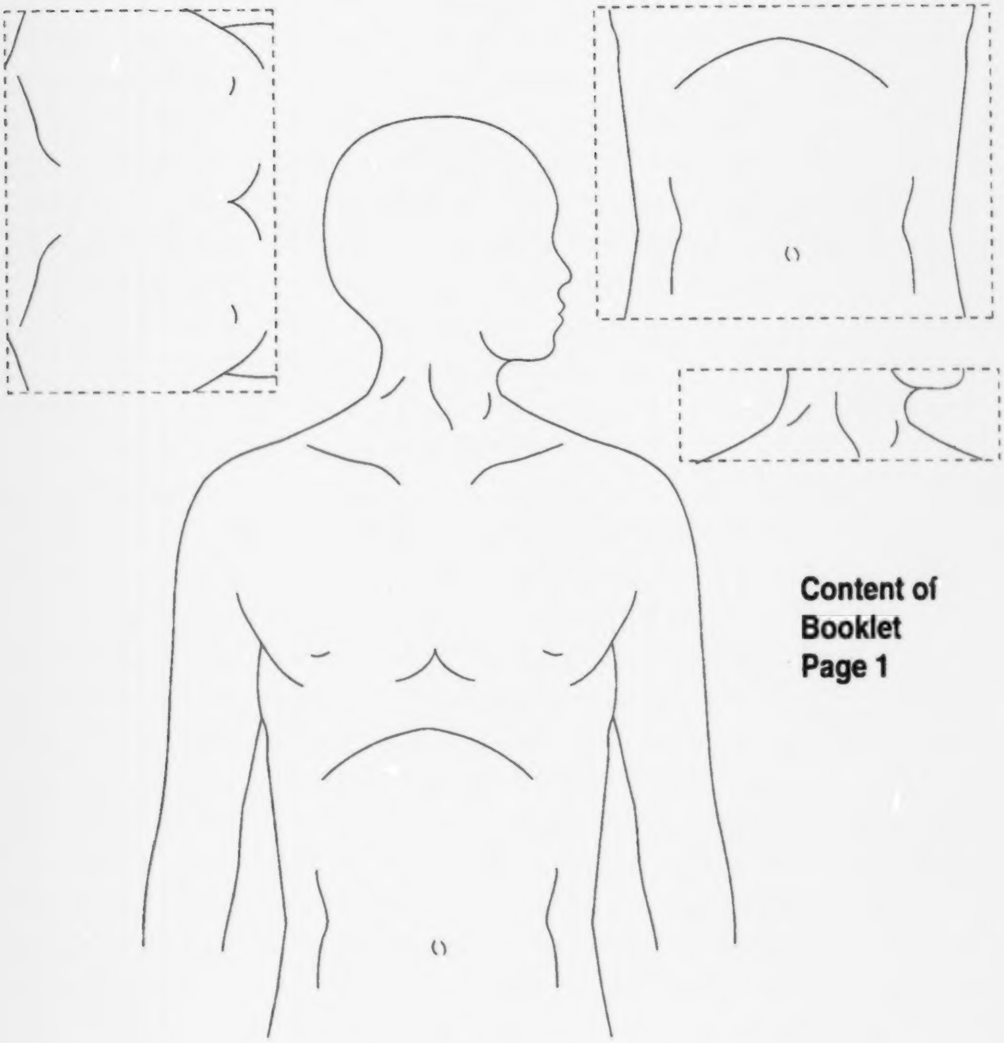


Figure 4.3.20(1) FRAME 1: View of External Anatomy (**uncompleted SP 4.3.20B)**



Content of Booklet Page 1

Figure 4.3.20(2) FRAME 1: View of External Anatomy **(completed SP 4.3.20B)**
Showing neck, chest, and abdomen added
This is the content of **page 1** of the anatomy booklet.

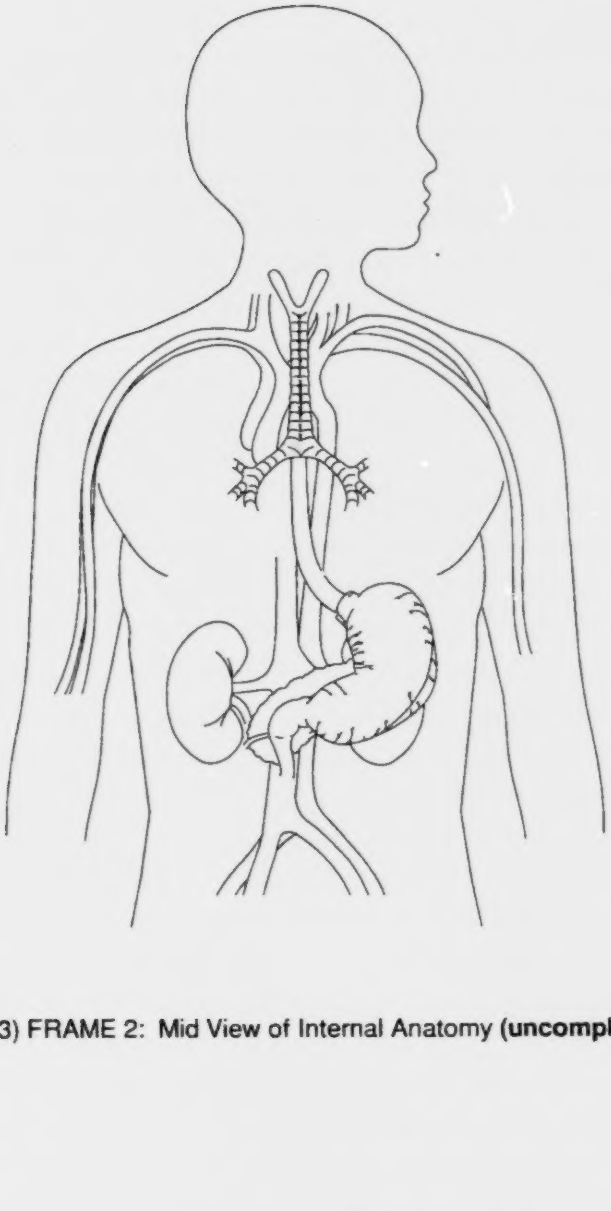
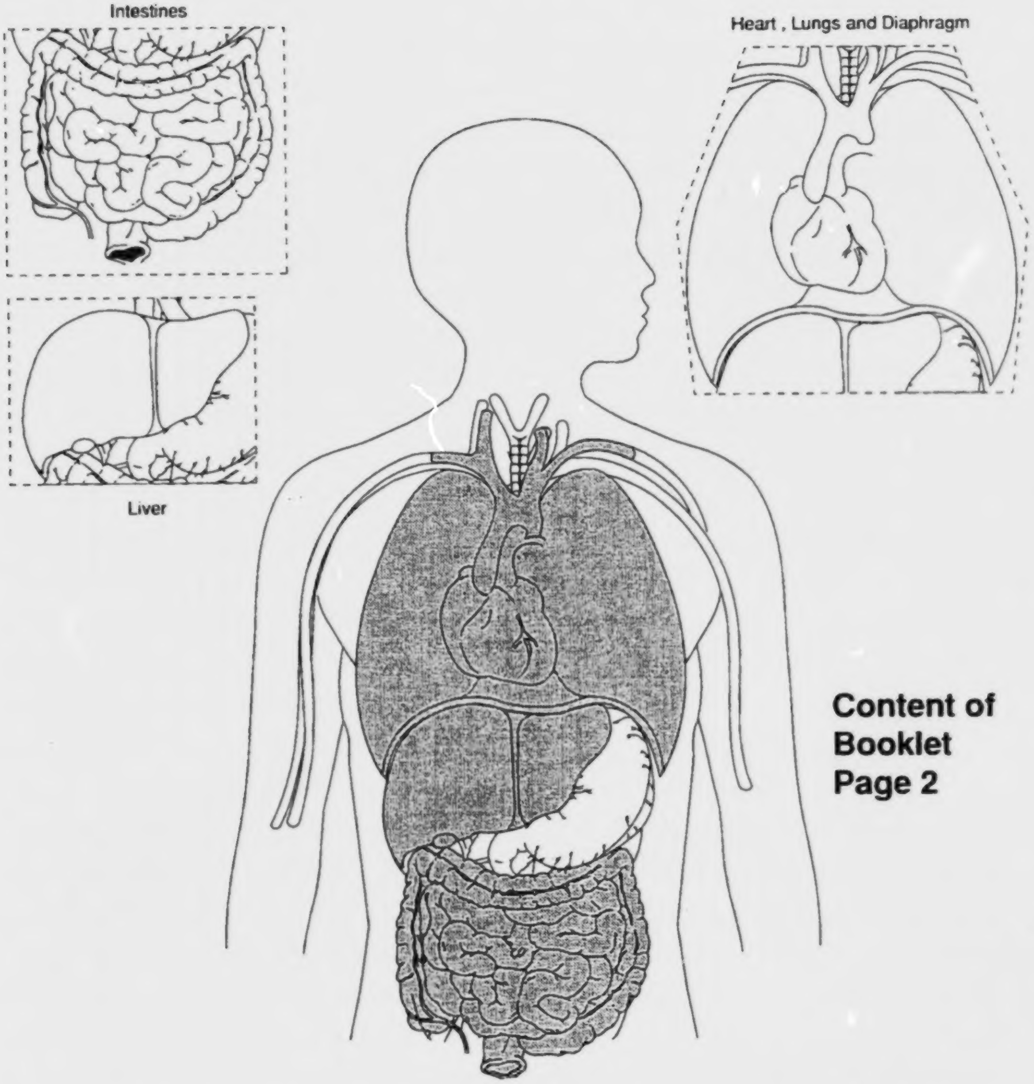


Figure 4.3.20(3) FRAME 2: Mid View of Internal Anatomy **(uncompleted SP 4.3.20C)**


Intestines
Liver
Heart , Lungs and Diaphragm

Content of Booklet Page 2

Figure 4.3.20(4) FRAME 2: Mid View of Internal Anatomy **(completed SP 4.3.20C)** Showing intestines, liver, heart, lungs, and diaphragm added. The paste-up is the content of **page 2** of the anatomy booklet.

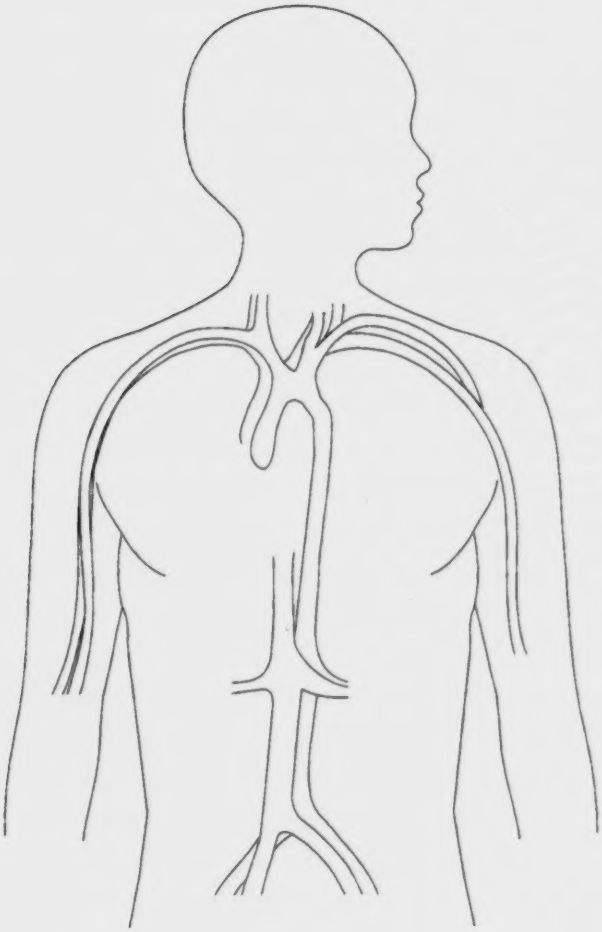
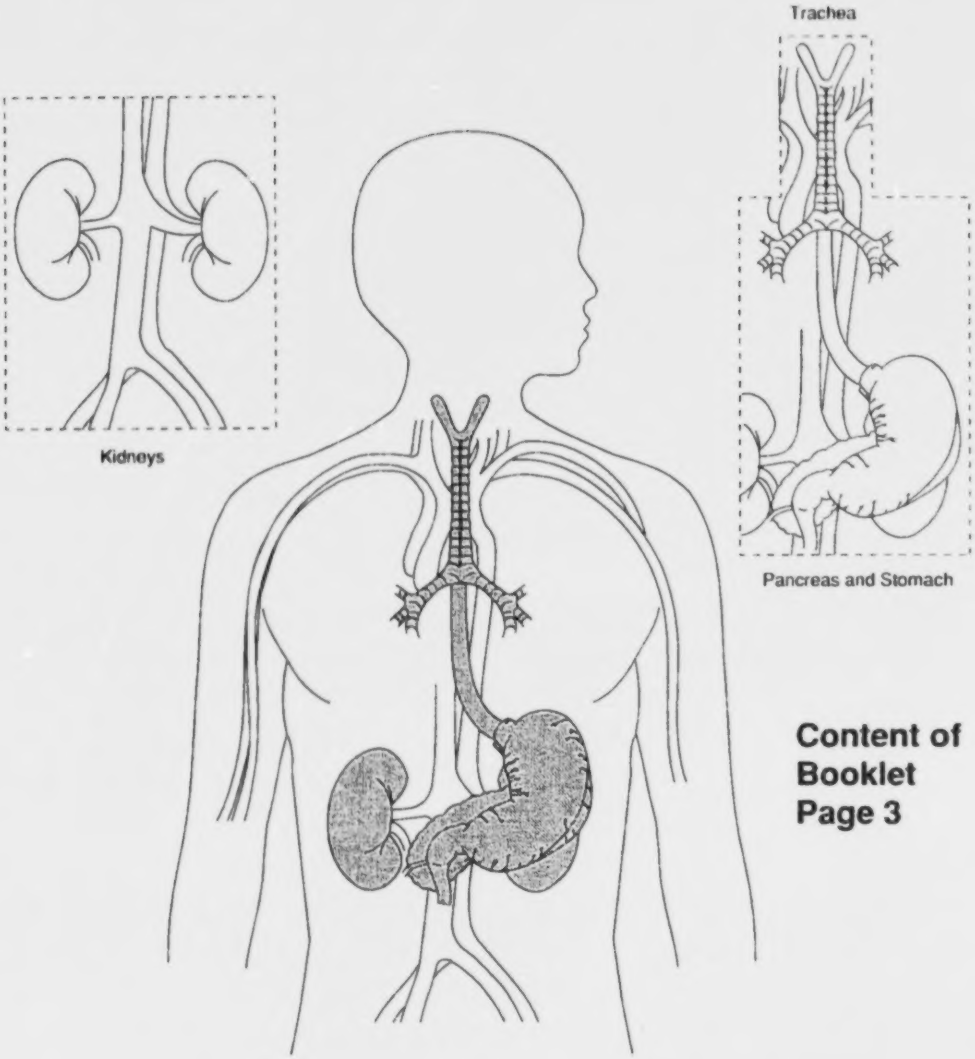


Figure 4.3.20(5) FRAME 3: Deep View of Internal Anatomy **(uncompleted SP 4.3.20D)**


Trachea
Kidneys
Pancreas and Stomach

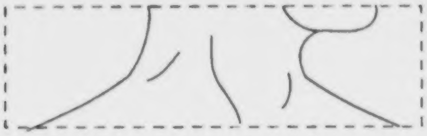
Content of Booklet Page 3

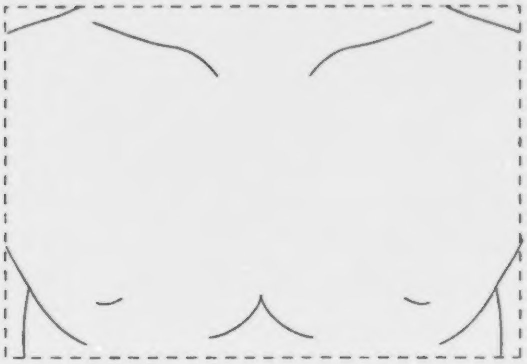
Figure 4.3.20(6) FRAME 3: Deep View of Internal Anatomy **(completed SP 4.3.20D)** Showing kidneys, stomach, pancreas, and trachea added. The paste-up is the content of **page 3** of the anatomy booklet.

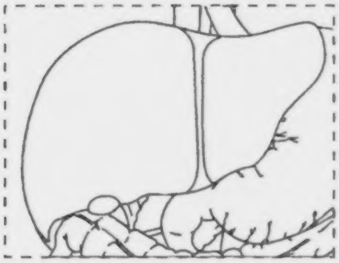
SP 4.3.20A
ANATOMIC PARTS

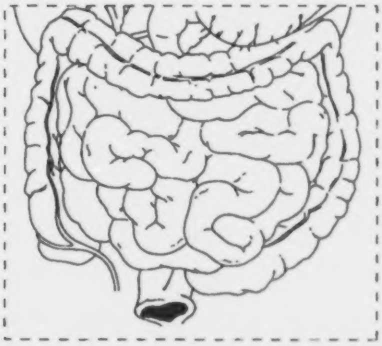
Name ______________________
Date ______________________

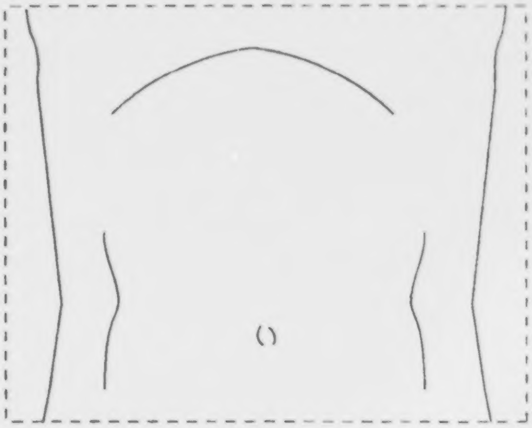
Cut out the parts and attach them to the proper frame.

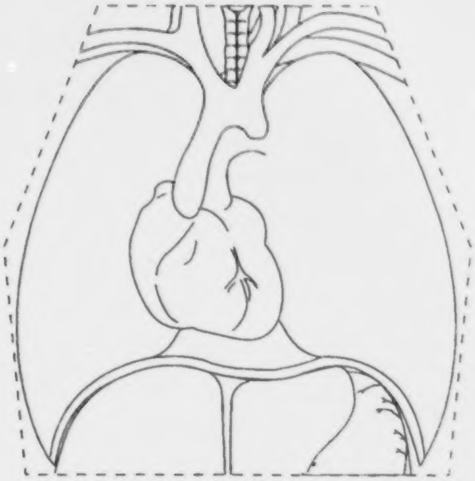

Neck


Chest

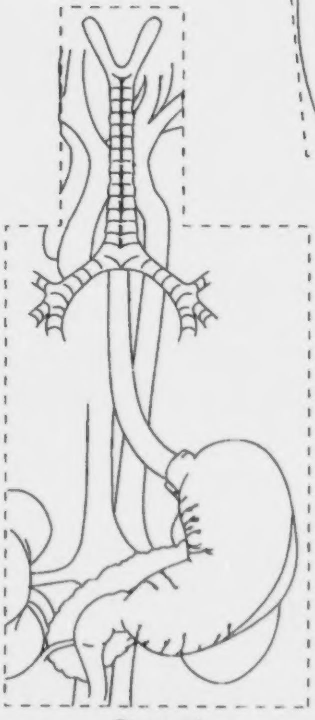

Liver


Intestines


Abdomen


Heart
Lungs
Diaphragm

Trachea


Stomach
Pancreas

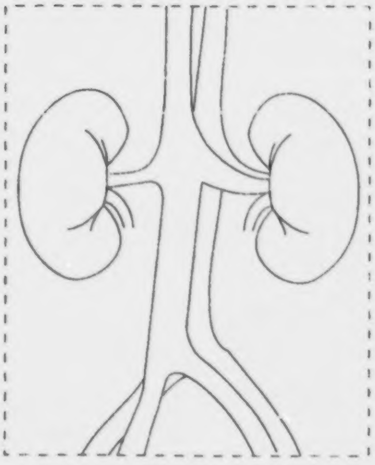

Kidneys

Figure SP 4.3.20A Anatomic parts

DASH	**SP 4.3.20B FRAME 1:** **VIEW OF EXTERNAL ANATOMY**	**Name** ____________ **Date** ____________

Attach cutouts of the neck,chest, and abdomen and label them.

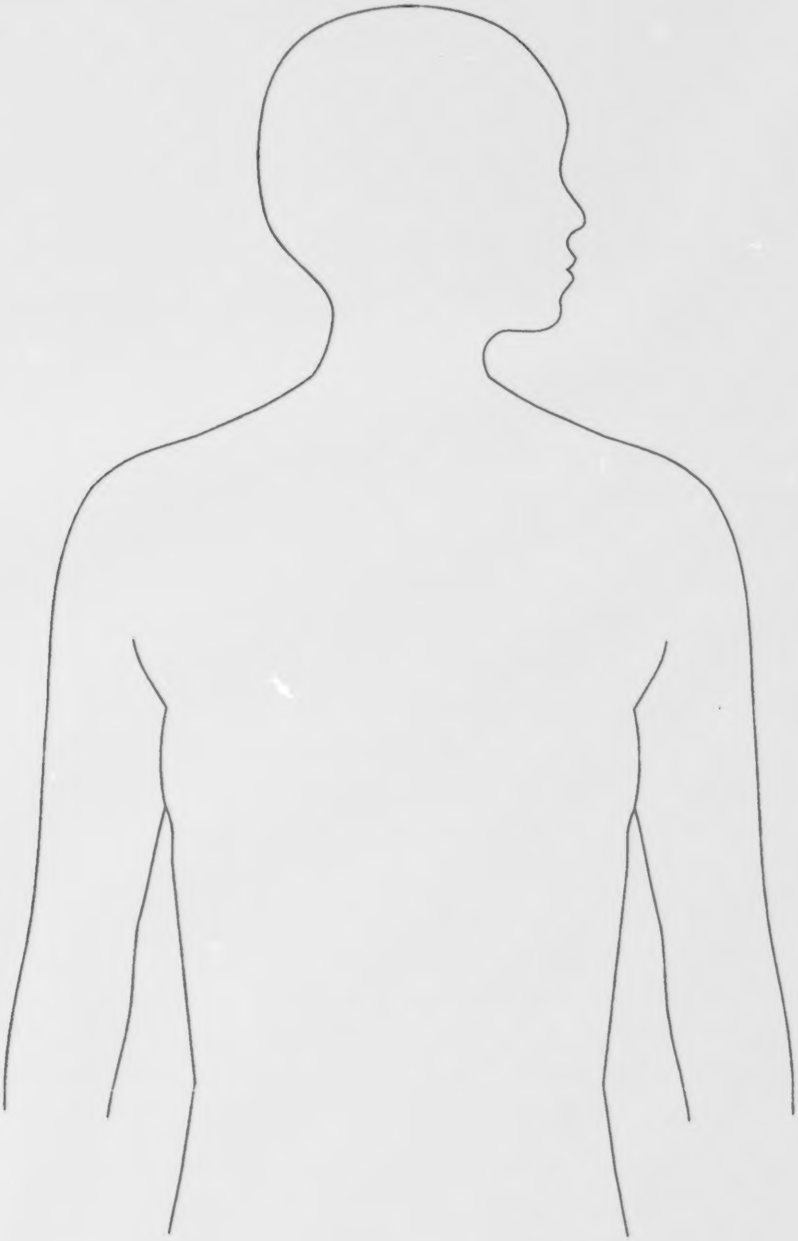


Figure SP 4.3.20B FRAME 1: View of External Anatomy

DASH	SP 4.3.20C FRAME 2: MID VIEW OF INTERNAL ANATOMY	Name ____________ Date ____________

Attach cutouts of the liver, heart, lungs, and diaphragm and label them.

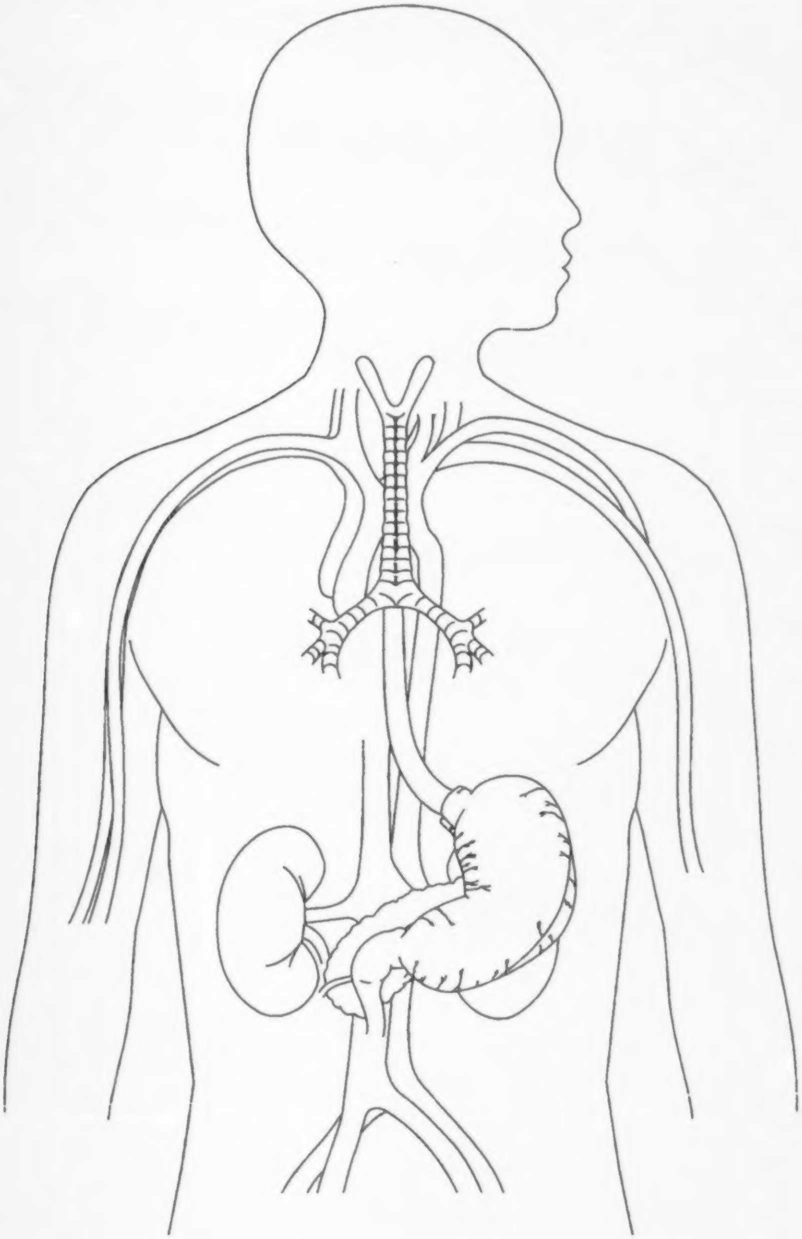


Figure SP 4.3.20C FRAME 2: Mid View of Internal Anatomy

DASH	SP 4.3.20D FRAME 3: DEEP VIEW OF INTERNAL ANATOMY	Name ____________ Date ____________

Attach cutouts of the kidneys, stomach, pancreas, and trachea and label them.

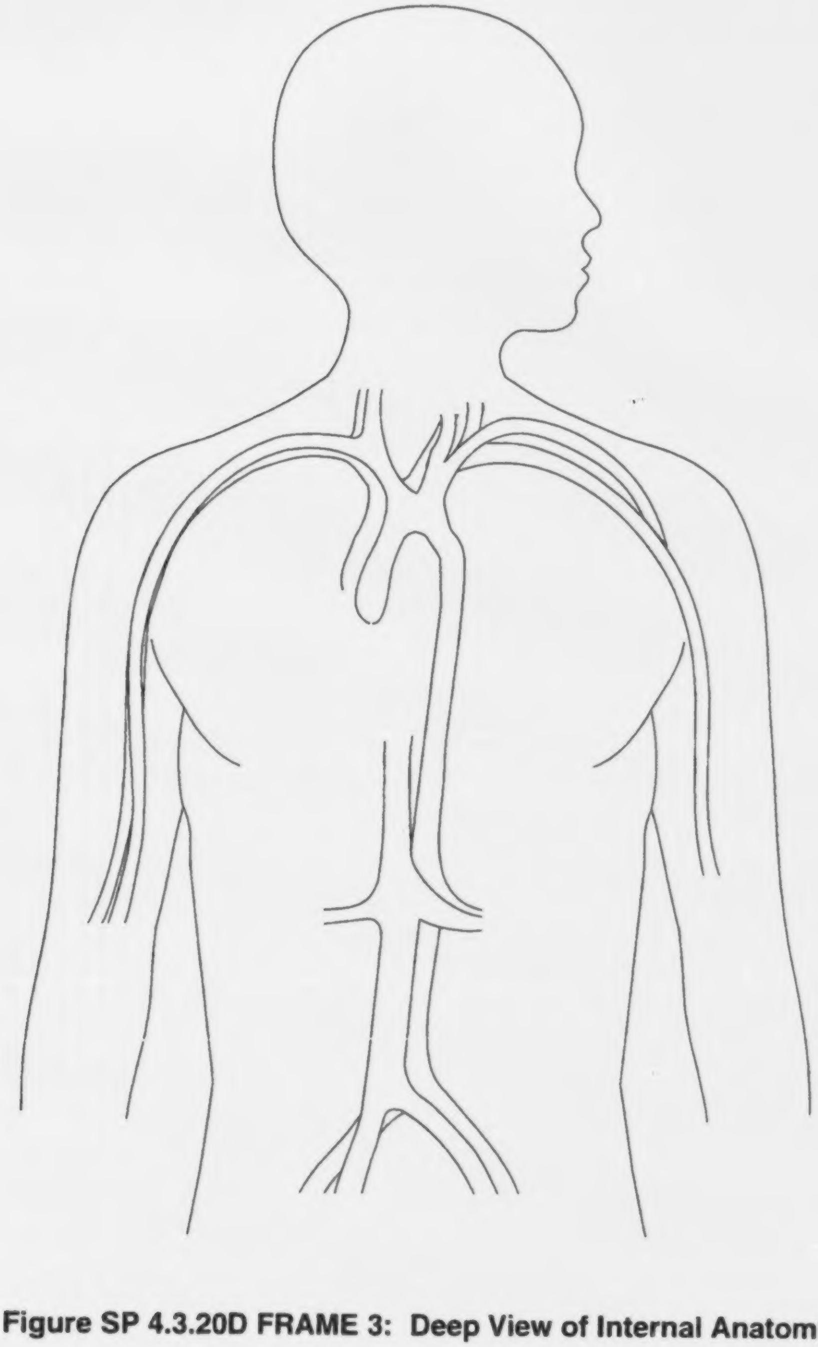


Figure SP 4.3.20D FRAME 3: Deep View of Internal Anatomy

ACTIVITY 4.3.21 LENGTH OF THE DIGESTIVE TRACT

OBJECTIVES

The students
- Determine the length of the various parts of their digestive tract.
- Make a linear string model of their digestive tract.

BACKGROUND

This activity follows Activities 4.3.18 MODELING OUR DIGESTIVE SYSTEM, 4.3.19 OUR DIGESTIVE SYSTEM IN TWO DIMENSIONS, AND 4.3.21 DIGESTIVE CIRCULATORY, AND RESPIRATORY SYSTEMS. It is designed to give the students a feeling for the length of the human digestive tract.

Approach

The students first estimate the length of their digestive tract. They then use their meter-string cans to measure the approximate length of their tract from the mouth to the anus.

If you want to show the width of the digestive tube, use crepe-paper strips 2.5 cm (1 in) wide to represent the small intestine and the esophagus. Use strips 5 cm (2 in) wide to represent the large intestine.

STUDENT ROLES

Anatomist
Internist

MATERIALS

Meter-string can
Scissors
Colored markers
Crepe-paper strips: 2.5-cm (1-in) and 5 cm wide (optional)
Tape
Cutouts from Student Page 4.3.18 LIFE-SIZED DIAGRAMS OF DIGESTIVE ORGANS
Student Page 4.3.21 LENGTH OF THE DIGESTIVE TRACT

PRODUCTS

Measurements of the digestive tract
Completed Student Pages

PROCEDURES

1. **Introduce the activity by asking the students to estimate the length of their digestive tract from the mouth to the anus.**

   Have them
   - Record their estimations on Student Page 4.3.21 LENGTH OF THE DIGESTIVE TRACT.
   - Pace off the estimated length of the digestive tract.

2. **Have the students use a meter-string can to measure the total length of their digestive tract and record it.**

   Have them make the following measurements:
   - Depth of the mouth.
   - Length of the esophagus from the back of the mouth to the bottom of the rib cage.
   - Length of the stomach (approximately the width of two fists).
   - Length of the small intestine (approximately four times the total length of the body).
   - Length of the ascending colon from the pelvis to the rib cage.
   - Length of the transverse colon (approximately the width of the rib cage.)
   - Length of the descending colon from the rib cage to the anus.

3. **Have the students stretch out the meter-string and attach the cutouts of the organs where they should appear in the body. See Student Page 4.3.18 LIFE-SIZED DIAGRAMS OF DIGESTIVE ORGANS.**

4. **Summarize the activity with the class.**

Ask such questions as

- Whose tracts are longer than others? (Get at the fact that the taller one is, the longer the digestive tract.)
- What happens to the length of the digestive tract as one gets older? (Work to the idea that it grows until adulthood is reached.)
- What advantages might there be in having a long digestive tract? (Work toward the suggestion that a long digestive tract might more completely digest the food and therefore get more nutrients from it.)
- What might be the reason for the need for numerous daily feeding for babies? (Get at the idea that a short intestine would mean a less efficient digestive tract during a time of rapid growth and would probably make regular and frequent feedings necessary.)
- What might account for the fact that problems of being overweight are far more common in adulthood than in childhood? (Again get discussion of the more efficient adult intestinal tract afforded by its greater length.)
- On average, how much longer is our digestive tract than our body? (It is normally about six times longer than our body.)

EXTENSION

Have the students

- Determine the length of the digestive tracts of other animals.

Name________________________

Date________________________

STUDENT PAGE 4.3.21 LENGTH OF THE DIGESTIVE TRACT

1. Record your estimate of the total length of your digestive tract. ________

2. Use your meter-string can to measure the total length of your digestive tract. Measure and record the following:

    - Depth of the mouth. ________
    - Length of the esophagus from the back of the mouth to the bottom of the rib cage. ________
    - Length of the stomach (approximately the width of two fists). ________
    - Length of the small intestine (approximately four times the total length of your body). ________
    - Length of the ascending colon from the pelvis to the rib cage. ________
    - Length of the transverse colon (approximately the width of the rib cage). ________
    - Length of the descending colon from the rib cage to the anus. ________

    TOTAL ________

3. What seems to determine the length of our digestive tract?

____

____

____

____

____

____

ACTIVITY 4.3.22 MIGRATION AND HIBERNATION

OBJECTIVES

The students
- Carry out research on migration and hibernation and report on what they find.
- Set up a migration-hibernation watch.

BACKGROUND

This is the first of a series of activities investigating the seasonal behavior of animals. It should be followed by 4.3.23 FALL BIRDS.

Approach

Migratory and hibernating animals were very important to hunters historically and remain so to hunters today. The students need to learn what animals migrate and hibernate in order to get a sense of the hunting practices of the past. Understanding of the present is based on understanding of the past. In this activity the students begin by studying local animals that migrate and hibernate. They then begin their research to find out what migrating and hibernating animals lived in the region of the school in the past.

The research here is left open to encourage student initiative. The study can be accelerated by inviting guest speakers from the Audubon Society, Sierra Club, or other organization concerned with the environment. An anthropologist can give insights about animals hunted in earlier times.

STUDENT ROLES

Anthropologist
Behavioral biologist (ethologist)
Naturalist
Hunter

MATERIALS

Newspapers
Student Page 4.3.22 MIGRATION AND HIBERNATION

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Help the students set up a research project on migration and hibernation.**

   Have them
   - Define the terms "migration" and "hibernation."
   - List the kinds of animals they know that migrate and hibernate.
   - Set up a research project to find animals in their area that migrate and hibernate today.
   - Set up a research project to find what animals migrated and hibernated in the area of the school 200 years ago, 10,000 years ago.

2. **Have the students carry out and report on their research.**

3. **Help the students set up a migration-hibernation watch.**

   Have the students report on
   - Personal observations.
   - Newspaper reports from the Learning Calendar.
   - Radio reports.

EXTENSIONS

- Have the students research what animals do when they hibernate.
- Show videotapes about animals that hibernate.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.22 MIGRATION AND HIBERNATION

1. List some local animals that migrate.

____

____

____

2. List some local animals that hibernate.

____

____

____

3. What other animals that lived in your region 200 years ago migrated and hibernated?

____

____

____

4. Record your observations of migrating and hibernating animals.

____

____

____

____

____

____

ACTIVITY 4.3.23 FALL BIRDS

OBJECTIVES

The students
- Recognize that many birds are migrating animals.
- Make and use feeding stations in the identification of birds.
- Practice identifying birds.
- Make a list of birds that come to their feeder in the fall.

BACKGROUND

This is one of a series of activities on hibernating and migrating animals. It should be followed by 4.3.24 WINTER BIRDS.

Approach
In FALL BIRDS the students try to find out by observation what birds will migrate during the year. They center their observation around bird feeders that they invent and build. Each student can be made responsible for helping to find answers to one or two questions.

For help in identifying birds you usually can call upon the local Audubon Society. General references can be used to find most birds. Such references as the Golden Field Guide to Birds and the Peterson Field Guide to Birds of North America are very useful.

STUDENT ROLES

Naturalist
Ornithologist

MATERIALS

Field or opera glasses.
Bird guide
Bird seed
Materials for feeders
Student Page 4.3.23 FALL BIRDS

PRODUCTS

Bird feeders
Completed Student Pages

PROCEDURES

1. **Establish that some birds are migrating animals.**

   Review the class research on migration and hibernation by asking such questions as
   - What do we mean by migration?
   - What animals in this area migrate? (Work toward the inclusion of birds.)

2. **Describe the feeding project and have the students formulate a set of research questions they would like to answer.**

   Help them include such questions as
   - Do all birds migrate?
   - Why do birds migrate?
   - If we feed birds, will they decide not to migrate?
   - How can we tell which birds migrate?
   - How could we use a feeding station to determine which birds migrate?
   - Do different birds eat at different times of day?
   - Do some kinds of birds have different eating behavior?
   - Which birds that come to the feeder could we eat?

3. **Have the students use feeding stations in the identification of birds.**

   Have them
   - Plan a feeding station.
   - Decide where to locate the station.
   - Decide how to keep out rats, cats, and vandals.
   - Make feeding stations.
   - Make rules for using the stations. (When to feed, how many students should observe at a time, how to handle weekend feeding, and so forth.)

4. **Have the students practice identifying birds.**

Have them

- Use a guide to local birds and practice identification.
- Set up procedures to verify identifications.
- Make a class list of birds that come to the feeder in the fall.
- Date the observations.
- Record the number of birds observed each time.
- Record the kind of bird observed.

EXTENSIONS

Have the students

- Make a list of birds identified off the school campus.
- Find out where different kinds of birds seem to stay at night and when it rains or snows.
- Find out what things birds can eat other than seeds.
- Find out whether the same birds come to the feeder when the kind of food is changed.

DASH

Name__________________________

Date__________________________

STUDENT PAGE 4.3.23 FALL BIRDS

1. Draw your bird feeder or feeders. Describe how large and small birds are accommodated.

2. What questions are you researching?

3. What answers did you find to your questions?

ACTIVITY 4.3.24 WINTER BIRDS

OBJECTIVES

The students

- Continue bird feeding.
- List birds that come to the feeder in the winter.
- List birds identified off the school campus.

BACKGROUND

This activity is part of the series on hibernation and migration. It should follow 4.3.23 FALL BIRDS and precede 4.3.25 SPRING BIRDS.

In WINTER BIRDS the students expand their list of research questions and report on changes in the bird population between fall and winter. In the Northern Hemisphere this activity should be done in December or January after migratory birds have departed.

STUDENT ROLES

Naturalist
Ornithologist

MATERIALS

Field or opera glasses.
Bird guide
Bird seed
Student Page 4.3.24 WINTER BIRDS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Have the students make preliminary reports on the research questions they set out to explore in the fall.**

2. **Continue observation at the feeder by having the students list the birds that come in the winter. Be sure that the observations are dated.**

3. **Have the students formulate additional research questions.**

   Help them include such things as
   - Do the birds feed when the weather is really bad?
   - Do the birds move and fly about as much on cold days as on warm days?
   - Do they have any change in plumage? (Is it thicker, lighter, darker, and so forth?)
   - Do the birds fight more over food in winter?
   - Are the birds that come to the feeder young birds, older birds, crippled birds? How can you tell?

4. **Have the students summarize their findings periodically.**

   Have them
   - State the questions they have been researching.
   - Organize their data for interpretation. (Have them be as quantitative as possible. For example, they can graph the percentages of different kinds of birds found at the feeder each week and graph the number of birds seen in different kinds of weather).
   - State their interpretation of their data.
   - Tell why they have made their interpretation.

EXTENSIONS

Have the students
- Work out a way to determine whether the same birds return each day.
- Try to find out whether the birds eat any other food besides that fed them.

DASH

Name________________________

Date_________________________

STUDENT PAGE 4.3.24 WINTER BIRDS

State the question or questions you are investigating and what you have found.

ACTIVITY 4.3.25 SPRING BIRDS

OBJECTIVES

The students
- Continue bird feeding.
- Make a list of birds that come to the feeder in the spring.
- Make a list of birds identified off the school campus.

BACKGROUND

This is the last activity of the migration and hibernation series. It should follow Activity 4.3.24 WINTER BIRDS.

In SPRING BIRDS the students continue their observation of birds as they return in the spring. They expand their research questions and summarize the entire bird watch sequence.

Next Year

Fourth grade observations should be kept in the Student Record Books for use in the fifth grade. Birds will again be a topic of focus, allowing the students to verify or challenge generalizations made in the fourth grade.

STUDENT ROLES

Naturalist
Anthologist

MATERIALS

Field or opera glasses.
Bird guide
Student Page 4.3.25 SPRING BIRDS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Continue bird observation by having the students list the birds that come to the feeder in the spring. Make sure they date their observations.**

   Ask such questions as
   - Do the birds have any change in plumage? (Is it lighter in color, less heavy, darker, and so forth?)
   - Do the birds fight more over food than they did in winter?
   - Are the birds young birds older birds? How can you tell?
   - Which kinds of birds have returned to the area?
   - Do the same kinds of birds look different from the way they looked in the fall? How?

2. **Summarize the fall, winter, spring sequence of observation.**

   Ask such questions as
   - Were you able to tell which birds migrated? How?
   - Did all members of that species (kind) of bird migrate? How can you tell?
   - What kinds of birds seemed to be in permanent residence?
   - Did the resident birds seem to have special needs or other characteristics that distinguished them from migratory birds? (Color, shape, size, age, infirmities, and so forth.)
   - How might bird migration have affected the diet of people long ago?

EXTENSION

- Have the students research where different kinds of birds they have observed spend the other part of their migratory cycle and when and where the birds hatch their young.

REFERENCES

McClung, Robert M.
1983 *Mysteries of Migration.* Garrard Publishing Company. Champaign, Illinois.

McGowen, Tom.
1982 *Album of Birds.* Rand McNally & Company. Chicago, Illinois.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.25 SPRING BIRDS

Describe what you observed about the birds that came to your feeder over the year.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.1 PET CARE

Describe what must be done to care for your pet animal.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.2 THE EGG

Record your working definitions for the following terms:

1. Organism

2. Male

3. Female

4. Reproduction

Name ______________________

5. Development

____

____

____

6. Metamorphosis

____

____

____

7. Embryo

____

____

____

8. Draw an unopened egg.

Name ______________________

9. Draw an opened egg and identify the parts listed in Item 11.

10. Draw the inside of an egg as it might appear through an unbroken transparent shell. Label the parts listed in Item 11.

Name ______________________

11. Suggest a function for each of the parts of the egg listed below.

PART	FUNCTION
A. Shell	
B. Shell membrane	
C. Air space	
D. Chalaza (dense ropey membrane attached to the yolk)	
E. Egg white (albumen)	
F. Yolk	
G. Yolk membrane	
H. Germinal disk (white spot on yolk)	

DASH

Name__________________________

Date___________________________

STUDENT PAGE 4.3.3 CHICK EMBRYOLOGY

1. Paste your shadow diagrams on this page in the order of the embryo development.

Name ______________________

2. Describe your study of the developing chick.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.4 SMALL MAMMAL REPORT

Write a report on an animal that might be selected as a pet. Include its size as an adult, its temperament, time it requires to reach adulthood, space requirements, cage requirements, food requirements, special environmental requirements, reproduction time, and other information needed to make a good selection.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.5 HOUSING PET MAMMALS

1. Record your design for a room of the animal house.

2. What is the purpose of this room? How does it fulfill that purpose?

3. How can the room be cleaned?

Name ______________________

4. **Describe how the animal house provides for the following:**

Water

____
____
____
____
____

Air

____
____
____
____
____
____

Exercise

____
____
____
____
____
____
____

Name ______________________

Waste Disposal

Nesting site for raising young

Privacy (especially for mice)

SP 4.3.6

Name________________________

Date________________________

DASH

STUDENT PAGE 4.3.6 PET HOME VISITS

1. Draw and label your design for portable housing to maintain pet mammals at home.

2. List the rules for caring for pets at home.

____

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Name________________________

Date________________________

STUDENT PAGE 4.3.7 PAIRING PET MAMMALS

Record your observations of the class pets.

DATE	NAME OF PET	OBSERVATIONS

DASH

Name______________________

Date______________________

STUDENT PAGE 4.3.8 REPRODUCTION OF PET MAMMALS

1. Describe the nesting behavior of your pet.

2. How did you measure the changes in the female? On a separate sheet of paper make a table of your measurements. Include the dates, measurements, and changes in measurement. Make a graph of the measurements over time. Use the attached graph paper.

3. Describe the changes in the size and shape of the female during the pregnancy.

Name ______________________

4. **Describe the birth of the babies.**

5. **Describe what the mother did with the babies after they were born.**

SP 4.3.8—3

Name ______________________

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.9 PET MATERNAL CARE

Record your questions and predictions about the newborn baby mammals and the responses of the mother. Record any observations that answer your questions or verify your predictions.

Name______________________

Date______________________

DASH

STUDENT PAGE 4.3.10 OUR EARLY YEARS

1. List the things you think newborn babies can do, can't do, and can learn.

2. List the things you think a toddler can do, can't do, and can learn.

Name ______________________

3. List the things you think a preschoolers can do, can't do, and can learn.

4. How are young children similar to and different from young animal pets?

DASH

Name________________________

Date_________________________

STUDENT PAGE 4.3.11 THE FIRST GRADE CHILD

1. List the questions you want to ask a first grader when you have your interview.

2. List a first grader's answers to your questions.

Name________________________

Date________________________

STUDENT PAGE 4.3.12 GROWTH, DEVELOPMENT, AND BEHAVIOR OF YOUNG PETS

1. Record your questions about the growth, development, and behavior of your young pets. Give your predictions of what you think you will find the answers to be. Record your observations of the animals and the answers you found to your questions.

QUESTIONS	PREDICTIONS	OBSERVATIONS	ANSWERS

Name ______________________

2. Collect data on two or more babies and record your data on the table below.

Name of baby	Type of Mammal	Date of Birth	Date Measured	Weight (g)	Body Length (cm)

Name ____________________

3. Graph the growth of two or more babies.

4. Describe the similarities and differences in the babies' growth.

____

____

____

____

____

DASH

Name__________________________

Date__________________________

STUDENT PAGE 4.3.13
HUMAN GROWTH AND DEVELOPMENT

1. List some ways your classmates have changed since birth.

2. How are human growth and development similar to your pets'? How are they different?

DASH

Name____________________________

Date____________________________

STUDENT PAGE 4.3.14 HOW I'VE GROWN

1. On the grid below trace the outlines of your baby handprint and footprint.

2. Calculate the area of your baby hand and foot.

Area of hand:	Area of foot:

3. Record your weight and length at birth.

Weight at birth:	Length at birth:

Name ______________________

4. Using your DASH Growth Charts and birth information, find your dimensions and record them below.

MEASUREMENT	BABY	K	1	2	3	4
Weight						
Height						
Hand Area						
Foot Area						

5. Graph the class growth data for each of the measurements above. Use the attached graph paper.

6. Describe your growth.

SP 4.3.14—3

Name ______________________

Name__________________________

Date__________________________

DASH

STUDENT PAGE 4.3.15 EXTERNAL ANATOMY OF A FISH

1. Draw a fish and label the structures listed in the table in Item 2.

Name ______________________

2. Complete the table below by filling in the functions of the listed structures.

STRUCTURE	FUNCTION
MOUTH	
NOSTRILS	
GILL COVERING	
ANUS	
UROGENITAL OPENING	
EYE	
PECTORAL FINS	
PELVIC FINS	
ANAL FIN	
TAIL FIN	
DORSAL FIN	

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.16
CLEANING FISH: INTERNAL ANATOMY

1. Draw the internal anatomy of a fish and label the organs listed in the table in Item 2.

Name ____________________

2. **Complete the table below by listing the functions of the internal organs of a fish.**

ORGAN	FUNCTION
TONGUE	
GILLS	
STOMACH	
INTESTINE	
PYLORIC CAECA	
ANUS	
KIDNEYS	
GONADS (TESTES, OVARIES)	
AIR BLADDER	
HEART	
LIVER	
BRAIN	
UROGENITAL OPENING	

DASH

Name____________________

Date____________________

STUDENT PAGE 4.3.17 FISH REPRODUCTION

Describe how fish reproduce.

DASH

Name________________________________

Date________________________________

STUDENT PAGE 4.3.18
LIFE-SIZED DIAGRAMS OF DIGESTIVE ORGANS

Color, cut out the organs on the following pages, and attach them to the body of a human model. Simulate the natural location as closely as possible.

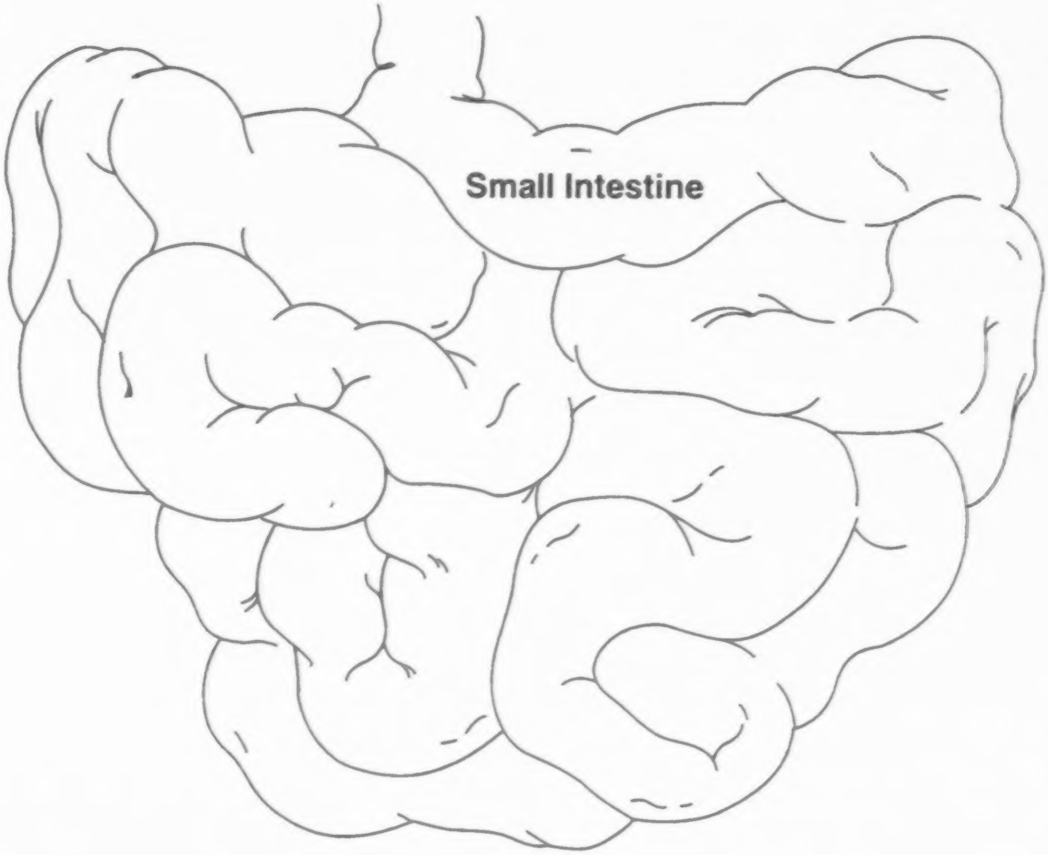


Figure SP 4.3.18(1) The small intestine

Name ______________________

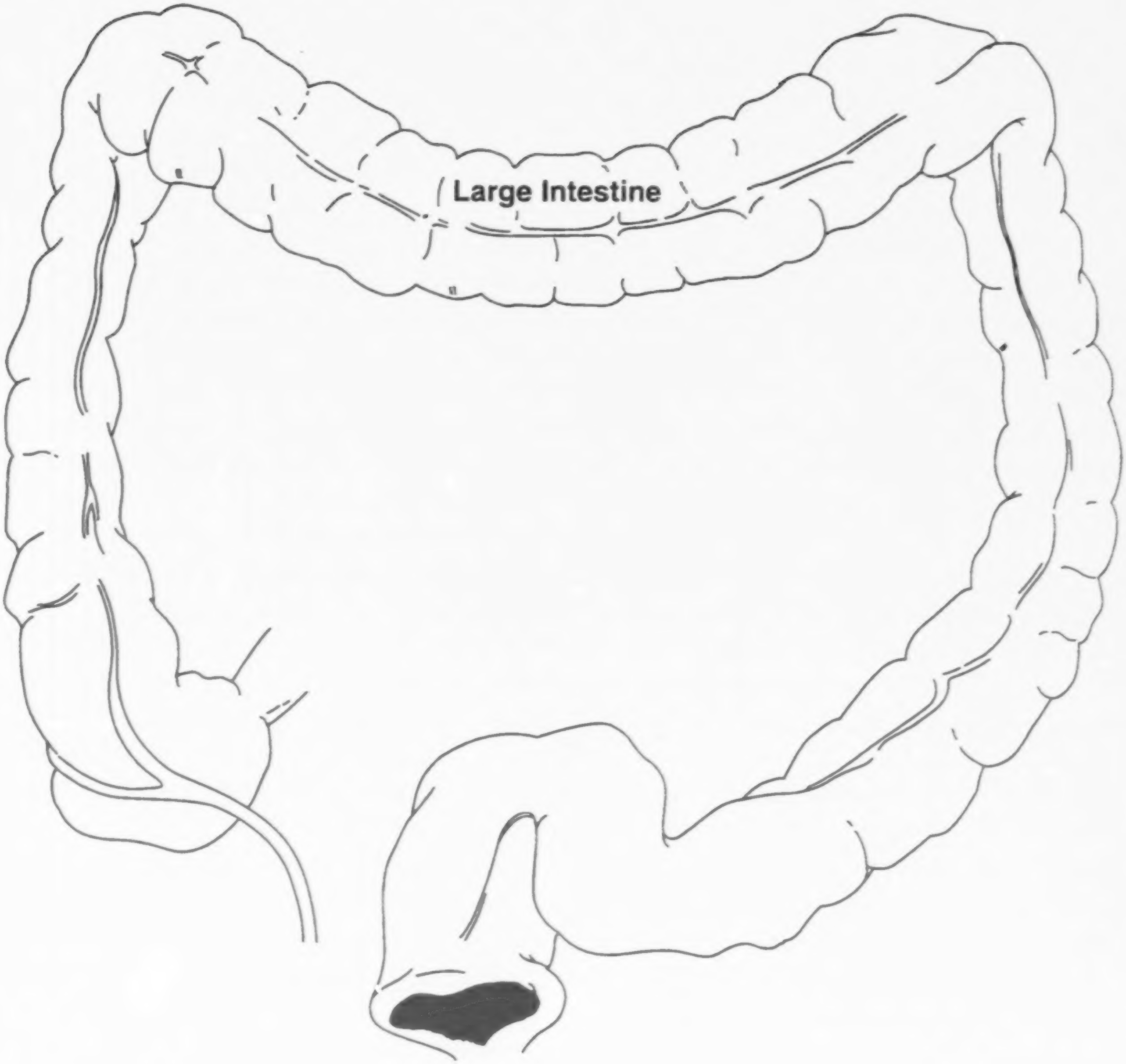

Large Intestine

Figure SP 4.3.18(2) The large intestine

Name ____________________

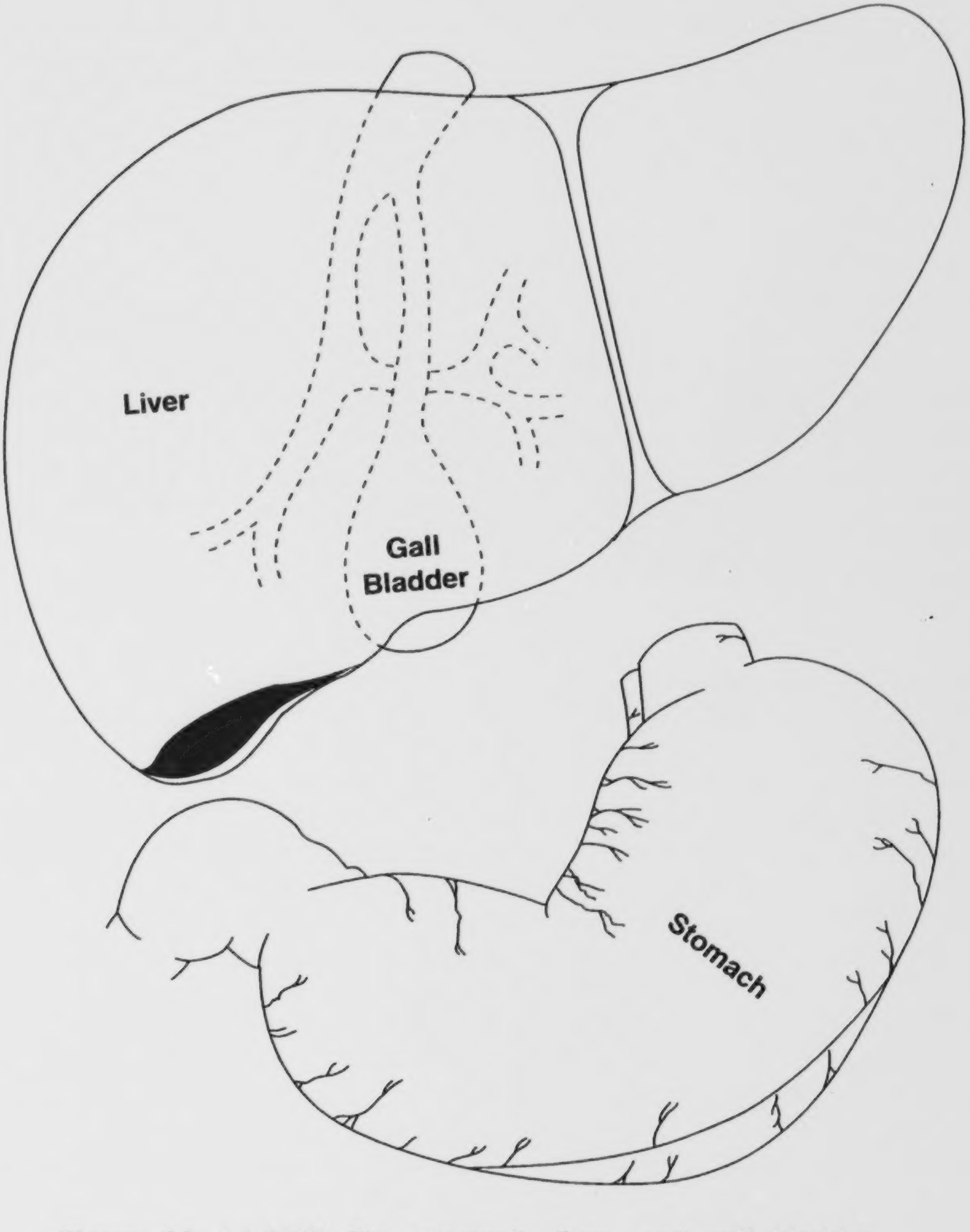

Liver
Gall
Bladder
Stomach

Figure SP 4.3.18(3) The stomach, liver, and gall bladder

Name ____________________________

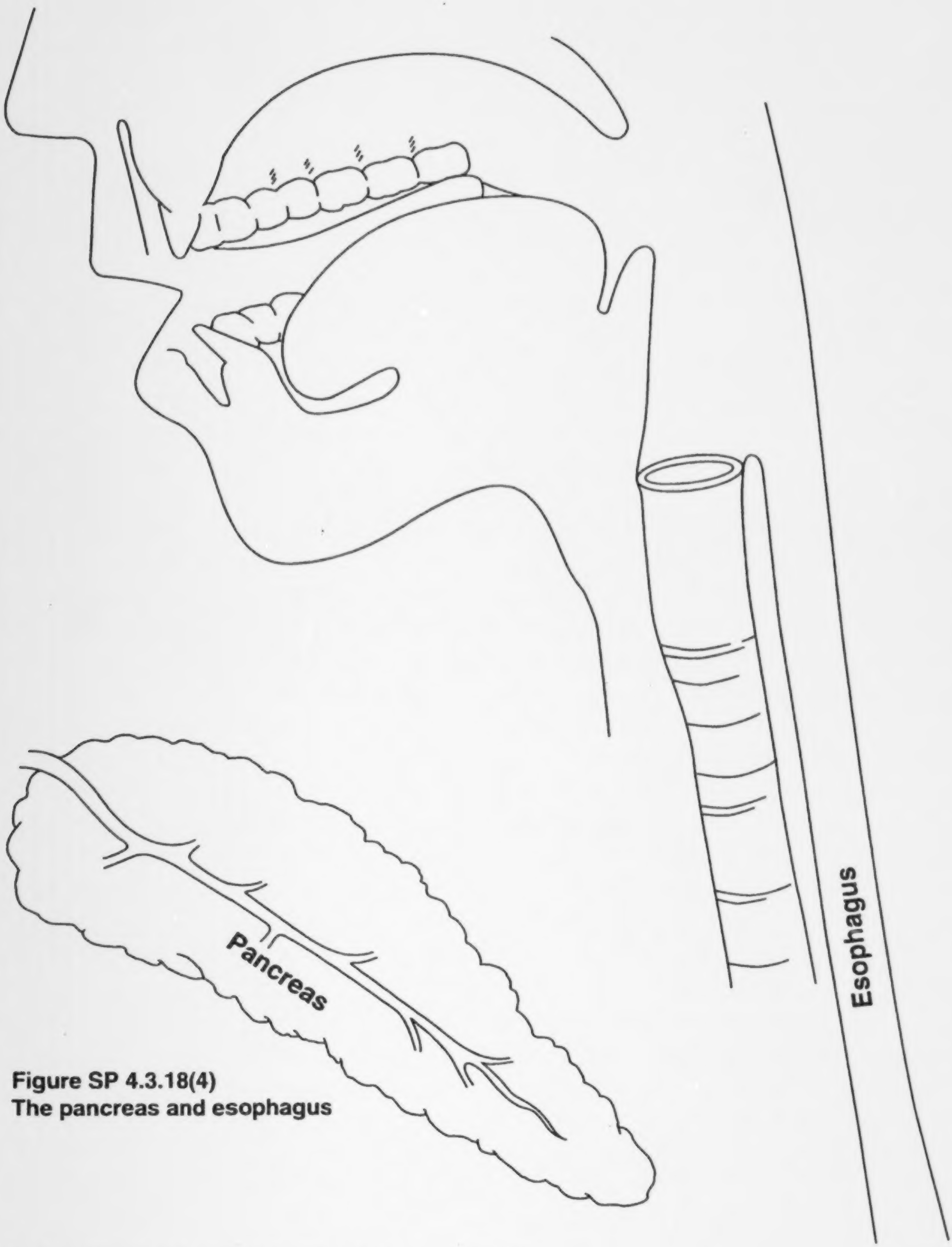

Pancreas
Esophagus

Figure SP 4.3.18(4)
The pancreas and esophagus

Name________________________

Date________________________

DASH

STUDENT PAGE 4.3.19
OUR DIGESTIVE SYSTEM IN TWO DIMENSIONS

Label the parts of the human digestive tract.

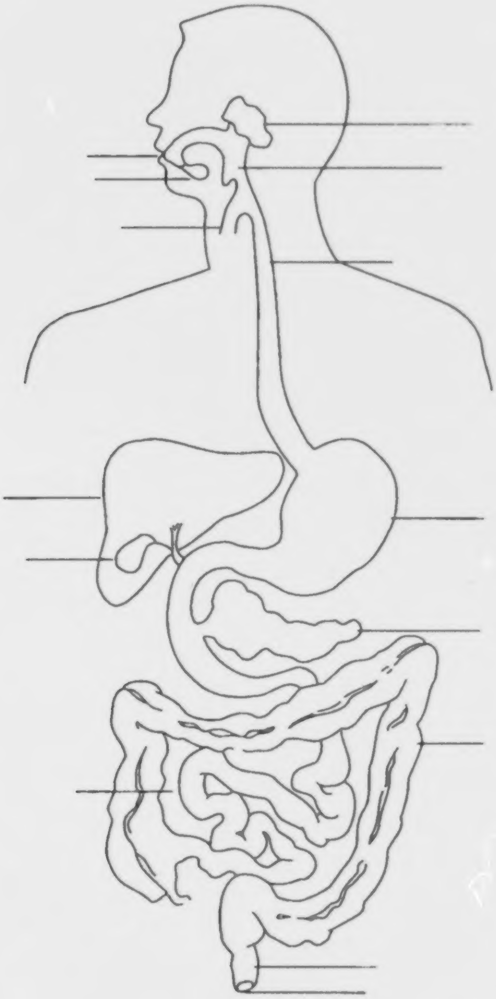


Figure SP 4.3.19 Two-dimensional diagram of the human digestive system

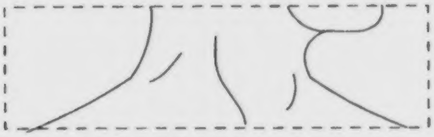
DASH

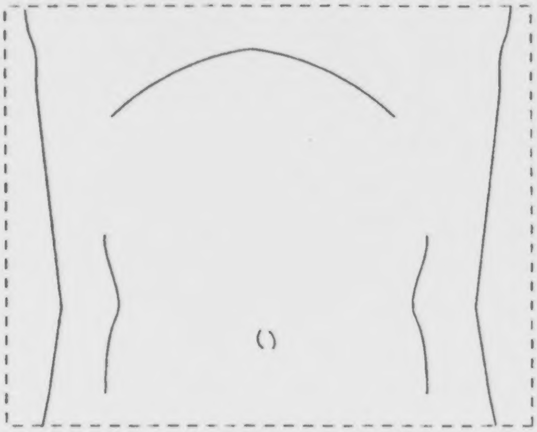
SP 4.3.20A
ANATOMIC PARTS

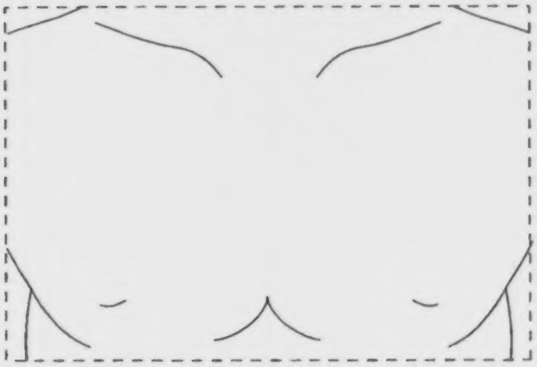
Name ____________________

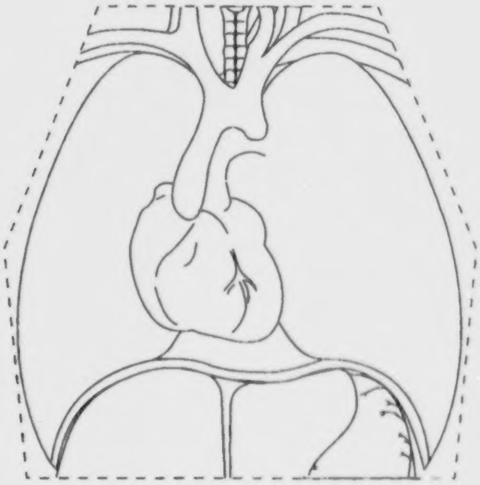
Date ____________________

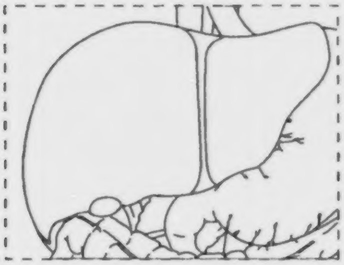
Cut out the parts and attach them to the proper frame.


Neck

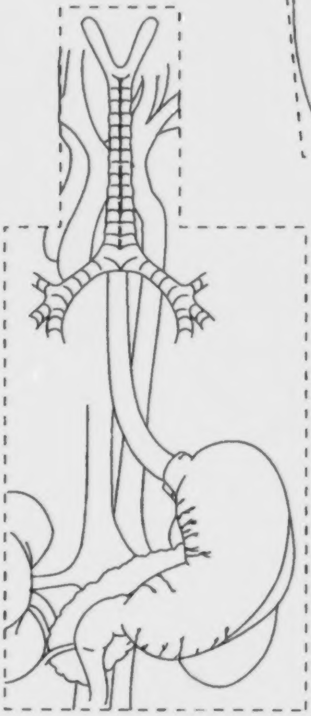

Abdomen

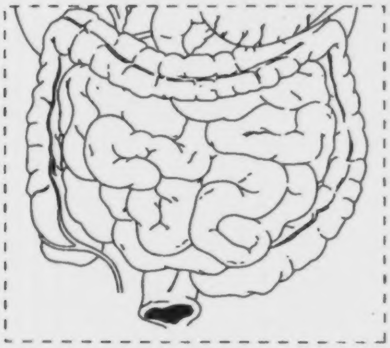

Chest


Heart
Lungs
Diaphragm


Liver

Trachea


Stomach
Pancreas


Intestines

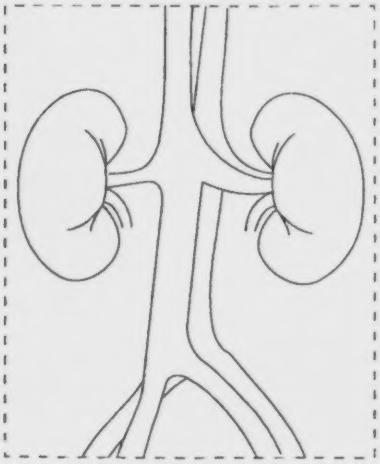

Kidneys

Figure SP 4.3.20A Anatomic parts

DASH	SP 4.3.20B FRAME 1: VIEW OF EXTERNAL ANATOMY	Name ____________ Date ____________

Attach cutouts of the neck,chest, and abdomen and label them.

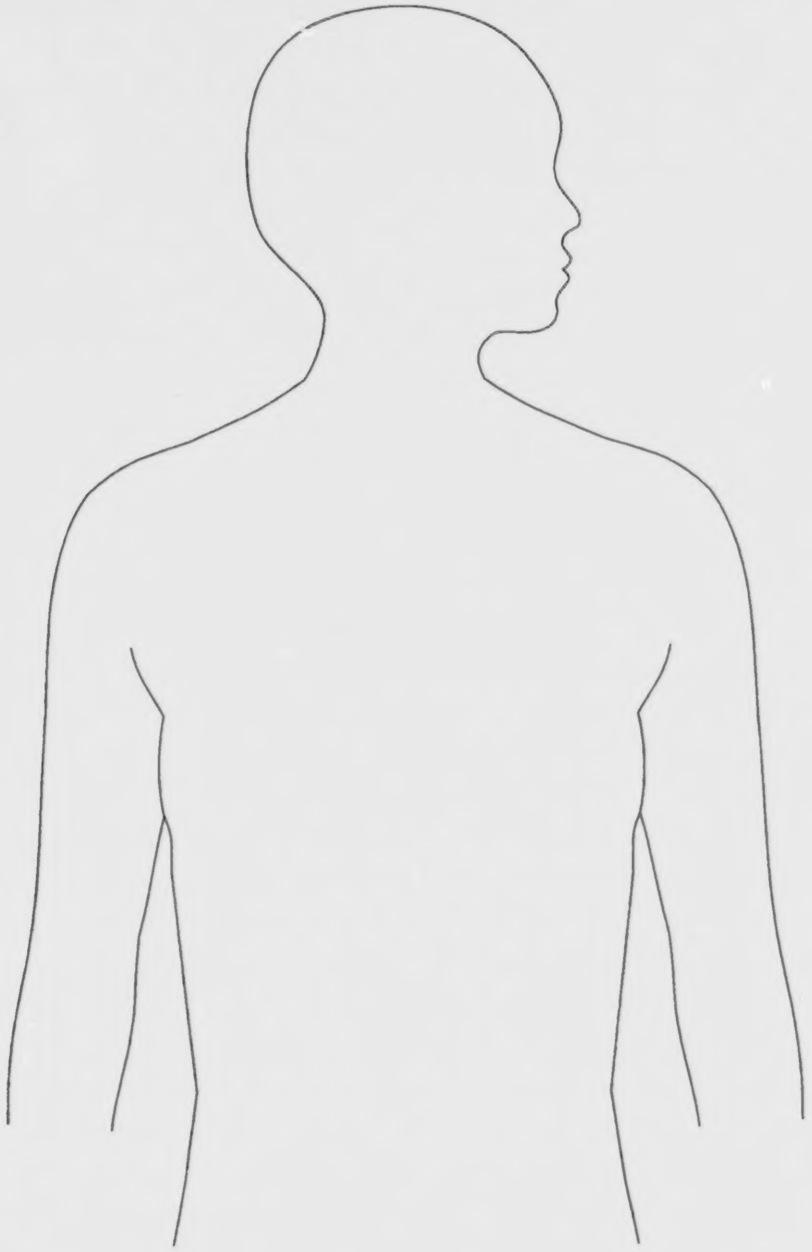


Figure SP 4.3.20B FRAME 1: View of External Anatomy

DASH	**SP 4.3.20C FRAME 2: MID VIEW OF INTERNAL ANATOMY**	**Name** ______________ **Date** ______________

Attach cutouts of the liver, heart, lungs, and diaphragm and label them.

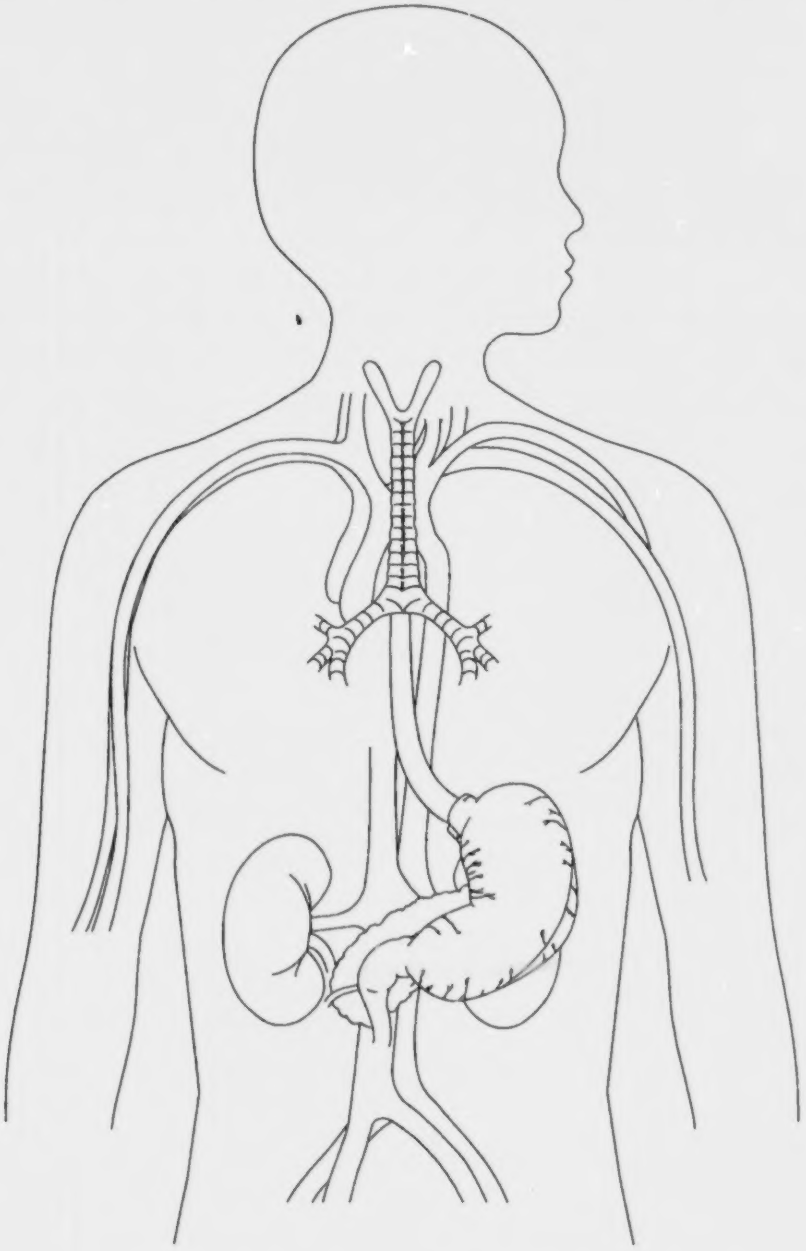


Figure SP 4.3.20C FRAME 2: Mid View of Internal Anatomy

SP 4.3.20D FRAME 3: DEEP VIEW OF INTERNAL ANATOMY	Name ______________________ Date ______________________

Attach cutouts of the kidneys, stomach, pancreas, and trachea and label them.

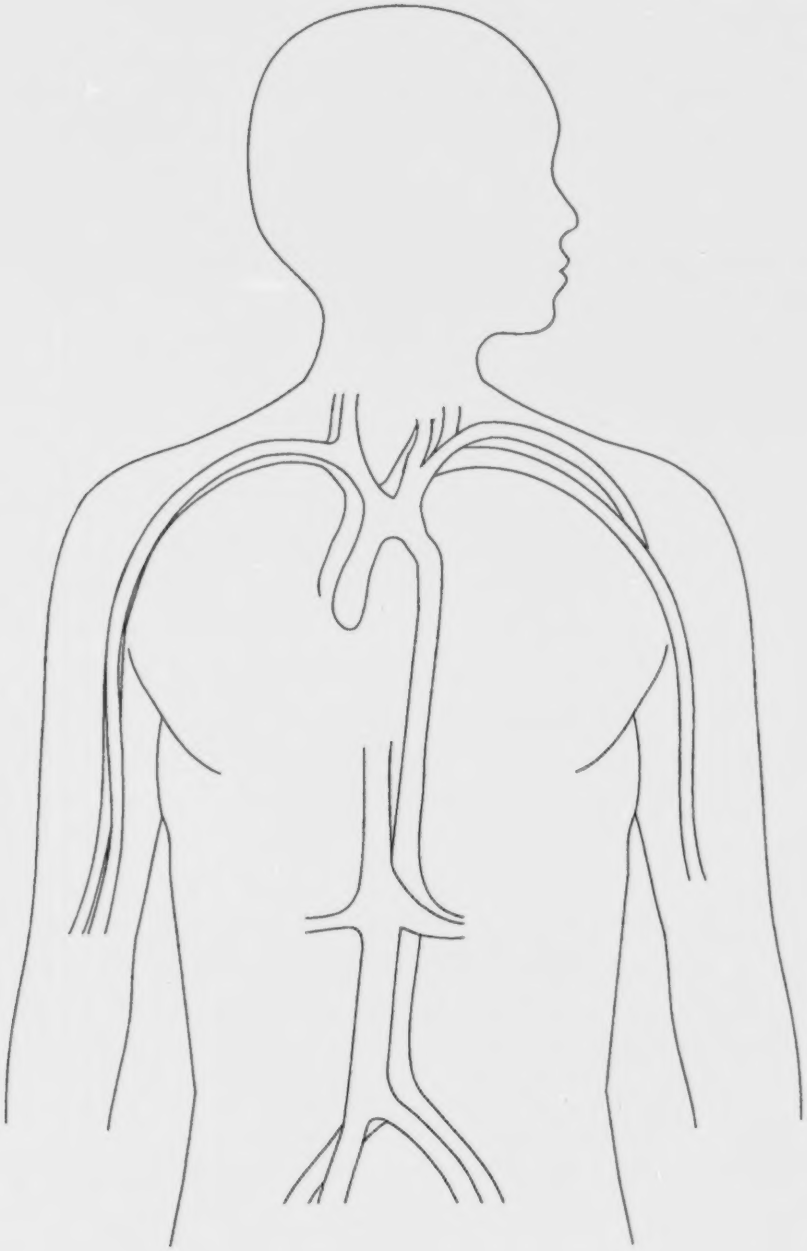


Figure SP 4.3.20D FRAME 3: Deep View of Internal Anatomy

583

DASH

Name____________________

Date____________________

STUDENT PAGE 4.3.21 LENGTH OF THE DIGESTIVE TRACT

1. Record your estimate of the total length of your digestive tract. ________

2. Use your meter-string can to measure the total length of your digestive tract. Measure and record the following:

- Depth of the mouth. ________
- Length of the esophagus from the back of the mouth to the bottom of the rib cage. ________
- Length of the stomach (approximately the width of two fists). ________
- Length of the small intestine (approximately four times the total length of your body). ________
- Length of the ascending colon from the pelvis to the rib cage. ________
- Length of the transverse colon (approximately the width of the rib cage). ________
- Length of the descending colon from the rib cage to the anus. ________

TOTAL ________

3. What seems to determine the length of our digestive tract?

____

____

____

____

____

____

DASH

Name________________________

Date_________________________

STUDENT PAGE 4.3.22 MIGRATION AND HIBERNATION

1. List some local animals that migrate.

2. List some local animals that hibernate.

3. What other animals that lived in your region 200 years ago migrated and hibernated?

4. Record your observations of migrating and hibernating animals.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.23 FALL BIRDS

1. **Draw your bird feeder or feeders. Describe how large and small birds are accommodated.**

2. **What questions are you researching?**

3. **What answers did you find to your questions?**

DASH

Name__________________________

Date__________________________

STUDENT PAGE 4.3.24 WINTER BIRDS

State the question or questions you are investigating and what you have found.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.3.25 SPRING BIRDS

Describe what you observed about the birds that came to your feeder over the year.

GRADE FOUR
CLUSTER 4

Plants

4.4.1 Annual, Biennial, and Perennial Garden Plants
4.4.2 The Fungus Among Us
4.4.3 Fungus Collection

ACTIVITY 4.4.1
ANNUAL, BIENNIAL, AND PERENNIAL GARDEN PLANTS

OBJECTIVES

The students
- Develop a concept map on garden plants.
- Develop a series of hypotheses about what happens to unharvested garden food plants.
- Carry out experiments.

BACKGROUND

To this point the students have mainly studied plants that are planted and harvested the same year. In this activity they design their own study to see whether garden plants (food and flower producers) survive and produce a second year. This brings out the nature of annuals (single season), biennials (double season), and perennials (multiseason). It may be done at home or at school. This kind of study gives the students many opportunities for open research. The activity should be followed up in grade 5.

Many garden plants can be raised in cans or pots—cherry tomatoes, bunch beans, carrots, radishes, onions, turnips, marigolds, daisies, and so forth. some schools may be able to let small parts of the DASH grade 3 garden go unharvested.

STUDENT ROLE

Botanist

MATERIALS

Seeds
Garden plot or cans with pans
Garden tools
Student Page 4.4.1 ANNUALS, BIENNIALS, AND PERENNIALS

PRODUCTS

Student reports
Completed Student Pages

PROCEDURES

1. **Have the students develop a concept map about garden plants.**

   Have them include
   - Seeds.
   - Seedlings.
   - Root plants.
   - Cultivation.
   - Harvesting.
   - Harvested plant parts. (Roots, stems, leaves, fruit, flowers, seeds.)

2. **Ask the students what they think would happen to plants in a garden if we did not harvest them.**

   Ask such questions as
   - What plants don't produce seeds before they are harvested? (Beets, carrots, parsnips, radishes, cabbages, onions, lettuce.)
   - What might happen to these plants if they were left to grow unharvested?
   - Would these plants produce flowers?
   - Would these garden plants die or would some live another season?
   - Would unharvested plants grow again the next year without being reseeded?
   - Do these plants have ways of reproducing other than by producing flowers and seeds?
   - Do any flower-producing plants blossom a second year? A third year?

3. **Ask the students what would happen to plants such as beans or tomatoes that are harvested if we did not pull them up.**

Ask such additional questions as
- Would these garden plants die or would some live another season?
- Would harvested plants grow again the next year without being reseeded?
- Do these plants have ways of reproducing other than by producing flowers and seeds?
- Do any flower-producing plants blossom a second year? A third year?

4. Have the students develop a way to answer one or more of the questions above or other similar questions.

Have them choose a question or questions to research and begin by
- Selecting a garden plant.
- Designing an experiment to answer their question(s).
- Calculating the time needed to run their experiment.
- Planning for the maintenance of their experiment.

5. Have the students carry out their experiments and complete Student Page 4.4.1 ANNUALS, BIENNIALS, AND PERENNIALS.

EXTENSION

Have the students research the following questions about biennials and perennials:
- Do all flowering plants produce flowers that emerge the year they are planted? (Biennials such as Sweet William and Canterbury bells don't. Perennials may take several years to mature and then flower for many years.)
- Do any flowering plants grow for several years without being replanted? (Perennials such as lilies, columbines, delphiniums, daisies, and flowering trees.)
- How do plants replant themselves?

Name________________________

Date________________________

STUDENT PAGE 4.4.1
ANNUALS, BIENNIALS, AND PERENNIALS

1. List the questions you are trying to answer.

2. Name the plant you plan to study. Tell why you chose this plant.

3. Describe how you plan to find the answers to your questions.

Name ________________________

4. Estimate the time it will take to find the answers.

____

5. Describe how you will maintain your investigation until the inquiry is finished.

____

____

____

____

____

6. Describe the result of your experiment.

____

____

____

____

____

594

ACTIVITY 4.4.2 THE FUNGUS AMONG US

OBJECTIVES

The students
- Do literature research on fungi.
- Report on their research.
- Arrive at a working definition of fungi.

BACKGROUND

This is the first of two activities exploring fungi. It is followed by Activity 4.4.3 FUNGUS COLLECTION. To help the students develop the ability to do literature research, they here investigate the economic importance of fungi. Any fungus including the following may be used for their reports:

smut fungi
rust fungi
edible mushrooms
poisonous mushrooms
Liederkranz cheese fungi
Gorgonzola cheese fungi
yeast and alcohol production
yeast and breads
truffles
water molds
slime mold
blue cheese fungi
ringworm
ICH (ichthyophthirius) fish disease
lichens
athlete's foot
puff balls
penicillin
mildew
food molds
Dutch elm disease
chestnut blight
bracket fungi

The students should be steered toward using field guides and encyclopedias for information.

STUDENT ROLE

Researcher

MATERIALS

Access to library facilities or class reference books.
Student Page 4.4.2 THE FUNGUS AMONG US

PRODUCTS

Student reports
Completed Student Pages

PROCEDURES

1. **Introduce the research through questions about molds.**

   Ask such questions as
   - What seems to make garbage and compost decompose? (Help the students list such things as insects, bacteria, and molds.)
   - What kind of decomposition have we observed? (This will vary from class to class. In DASH classes the students will have observed decomposition of food, possibly the decomposition of a pumpkin.)
   - What color were the molds that we have seen?
   - Where else have you seen molds?
   - Aside from decomposing our garbage, can you think of anything else that molds do that helps us?
   - Can you think of things that molds do that work against human interest?

2. **Explain that the molds we have seen are part of a larger group of organisms called "fungi" and we are going to do research on them.**

   Set out the research plan by having the students ask themselves such questions about their projects as
   - What does my fungus look like?
   - What does my fungus do?
   - Where is my fungi found?
   - In what way is my fungus important to humans?
   - How does my fungus reproduce?
   - What other interesting things can I say about my fungus?

3. Have the students give their reports on fungi. Have them use Student Page 4.4.2 THE FUNGUS AMONG US for recording.

- Give a report on their fungi to the class.
- Open each report to discussion.
- List additional questions in the Wonder and Discover Book.
- Define the terms **fungus** and **fungi** in the Working Dictionary.

EXTENSION

- Have the students make a bulletin board display about incredible fungi.

Name________________________

Date________________________

STUDENT PAGE 4.4.2 THE FUNGUS AMONG US

Make oral and written reports on a fungus describing the importance of the fungus to humans.

ACTIVITY 4.4.3 FUNGUS COLLECTION

OBJECTIVES

The students
- Make a collection of fungi.
- Observe fungi.

BACKGROUND

This is the second of a sequence of activities investigating fungi. It follows Activity 4.4.2 THE FUNGUS AMONG US. In FUNGUS COLLECTION the students collect fungi and make herbarium sheets to preserve them. Have them bring in the fungi in large plastic resealable bags. Some students may have a sensitivity to fungi and should not be assigned to collect them.

To reduce the possibility of fungus spores getting into the room, keep fungus samples in large resealable plastic bags, placing the fungi on a sheet of absorbent white paper. Place newsprint under the white paper.

A herbarium press can be made by covering plastic bags of fungus samples with newspaper and stacking them one on top of the other. On top of the stack place a board with a cement block or other heavy weight on it. Seal the bags after they are put under pressure in the press.

STUDENT ROLES

Researcher
Mycologist

MATERIALS

Newsprint
Absorbent white paper
Resealable plastic bags
Student Page 4.4.3 FUNGUS COLLECTION

PRODUCTS

Fungus collection

PROCEDURES

1. **Extend the fungus research by explaining that now that we have researched fungi, we are going to collect some samples.**

   Have the students
   - Bring in samples of fungi in plastic bags.
   - Observe sanitation practices by washing their hands after handling fungi.
   - Place their sample on a piece of absorbent white paper that will fit completely into a resealable plastic bag.
   - Place 3–5 strips of newsprint behind the white paper to absorb the moisture. Let the strips extend outside the bag.
   - Put a label in the bag to identify the fungi.
   - If the names of the fungi are not known, record descriptions of the location where they were found.
   - Fold a piece of newspaper around each bag and place the plastic bags with their extended newsprint in a herbarium press. Let them stand for several weeks.
   - Work outdoors.
   - After the fungi are dry, remove the newsprint strips and seal the bags and secure them with tape. Samples can be stored to make a classroom collection.

2. **Summarize the activity.**

   Have the students
   - Observe what has happened to the fungi while they were in the press.
   - Tell what kind of fungus they have collected.
   - Compare the fungi with samples collected in previous years.

EXTENSIONS

Have the students
- Make a book of their herbarium sheets.
- Identify their fungi using field guides

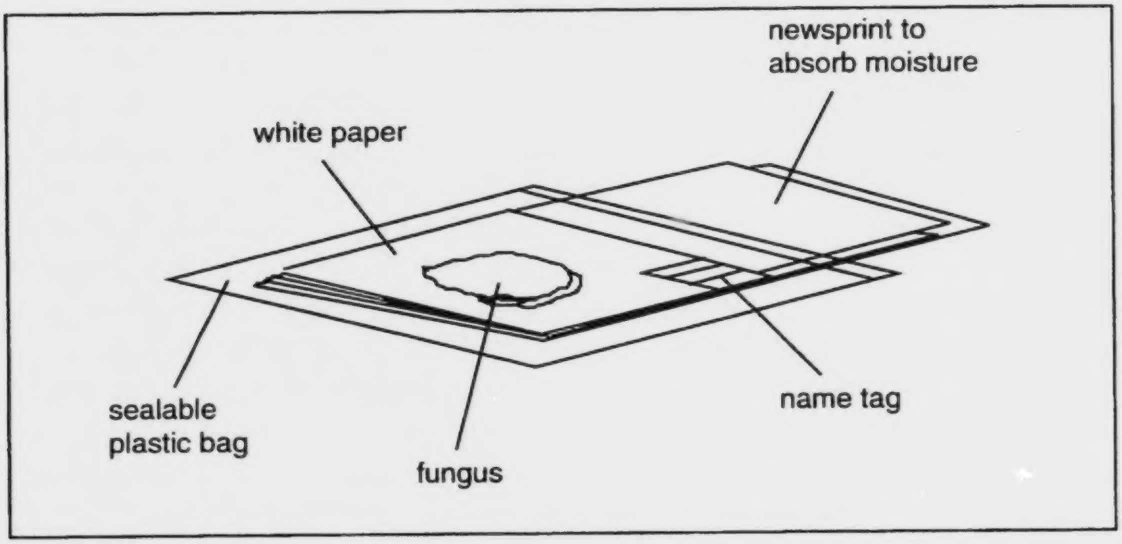

newsprint to
absorb moisture
white paper
sealable
plastic bag
fungus
name tag

Figure 4.4.3 Technique for pressing fungi

Name________________________

Date________________________

STUDENT PAGE 4.4.3 FUNGUS COLLECTION

1. Describe the different types of fungi collected by the class.

2. Describe what happened to the fungi when they were in the press.

DASH

Name____________________________

Date____________________________

STUDENT PAGE 4.4.1
ANNUALS, BIENNIALS, AND PERENNIALS

1. **List the questions you are trying to answer.**

____
____
____
____
____

2. **Name the plant you plan to study. Tell why you chose this plant.**

____
____
____
____
____

3. **Describe how you plan to find the answers to your questions.**

____
____
____
____
____

Name ________________________

4. Estimate the time it will take to find the answers.

____

5. Describe how you will maintain your investigation until the inquiry is finished.

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6. Describe the result of your experiment.

____

____

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____

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Name________________________

Date________________________

STUDENT PAGE 4.4.2 THE FUNGUS AMONG US

Make oral and written reports on a fungus describing the importance of the fungus to humans.

Name______________________

Date______________________

STUDENT PAGE 4.4.3 FUNGUS COLLECTION

1. Describe the different types of fungi collected by the class.

2. Describe what happened to the fungi when they were in the press.

DASH

GRADE FOUR
CLUSTER 5

Food and Nutrition

4.5.1 Nutrition Messages
4.5.2 Mechanical Digestion
4.5.3 Chemical Digestion
4.5.4 Food Groups
4.5.5 Digestion Game
4.5.6 Preserving Foods

ACTIVITY 4.5.1 NUTRITION MESSAGES

OBJECTIVES

The students
- Decode messages about nutrients.
- Identify the functions of the nutrients in the body.
- Develop working definitions of the term "nutrients."

BACKGROUND

This is the first of a series of activities on digestion and nutrients. It should be followed by Activity 4.5.2 MECHANICAL DIGESTION. At this point in their inquiry into digestion and nutrition, much of what the students hear is like a secret code—the meanings of the different terms need decoding. In this activity they symbolically start to decode the secret language of nutrition.

Two-Person Game

The decoder sheets can be used as a game with two players:
- When a word is to be decoded, the first player makes a word guess and states what the word will be.
- The second player may also make a guess if the guess is different from that of the first player. Then decoding begins.
- Players may let their first guess stand or make another guess anytime before the word is completely decoded.
- The person who first correctly identifies the word gets a point.

Other Ways to Organize Decoding

The decoding of the secret messages can be done in task-saving groups with each group reading its message to other groups. This can be done as homework or as work in a learning center. The teacher may want to encode the assignment on the board for practice. There is an optional (OPT) code for this purpose.

STUDENT ROLES

Nutritionist
Cryptographer
Physician

MATERIALS

Student Page 4.5.1 NUTRITION SECRET MESSAGES

PRODUCTS

Completed Student Pages

1. **Discuss decoding messages.**

   Ask such questions as
   - What is a **code?**
   - What does **decoding** mean?
   - What coding systems are presently in use? (Help the students identify bar codes on foodstuffs, phone numbers, codes in espionage, language as a code.)

2. **Ask the students to decode the message about Tissues, Cells, and Nutrients. Introduce the Nutrition Secret Message Code and Decoder Sheets.**

   Have the students
   - Develop a working definition of the term **nutrients**.
   - Explain in their own words how the different nutrients work in their bodies.
   - Discuss why nutrients are important to the process of **activation.**
   - Discuss why nutrients are important to the process of **regulation.**
   - Discuss why nutrients are important to the process of **fabrication.**

3. **Have the students decode the rest of the messages.**

4. **Summarize the messages and have the students develop a working definition of each nutrient. Have them use Student Page 4.5.1 NUTRITION SECRET MESSAGES.**

Ask such questions as
- What is the function of the nutrient?
- Where do we get the nutrient?
- Where is the nutrient digested?

EXTENSIONS

Have the students
- Write a short definition of nutrients in code using columns on the decoding sheet.
- Exchange their coded definitions and decode them.

DECODED MESSAGES

Code
TIS **TISSUE, CELLS, NUTRIENTS**
Pages 1–3

1. Our bodies are made of parts that we call organs. Examples of organs include our heart, lungs, stomach, intestines, eyes, and legs. Each organ plays a special role in our body. Our heart pumps blood; our lungs exchange carbon dioxide for oxygen.

2. Organs are made of parts called tissues that are made of other parts called cells. Cells are the units out of which living things are built. The cells in tissues can be seen only under a microscope.

3. Examples of tissues include muscles, skin, hair, bone, nerves, and blood.

4. Blood is a tissue that carries oxygen and nutrients to other tissues in our bodies. It carries carbon dioxide and other waste away from tissues. In our lungs the blood gives up the carbon dioxide to the air. Other waste goes to the kidneys for removal through the process of urination.

5. Food comes from living things that are also made of tissues and cells. Cells are built from chemical parts called nutrients. In the digestion process cells are broken down into nutrients. Our bodies are built out of these nutrients.

6. Six types of nutrients exist. They are proteins, fats, carbohydrates, minerals, vitamins, and water.

7. Nutrients have three basic functions in our bodies. First, they are used as fuels to activate our bodies.

8. Second, they provide chemicals to regulate our bodily processes of growing, thinking, reproducing, moving, breathing, seeing, and many more.

Code
TIS
contd.

9. Third, nutrients are used to fabricate or build our bodies.

10. Different foods are especially rich in different nutrients. For example, potatoes and rice are especially rich in carbohydrates, butter and margarine are especially rich in fat, meat is rich in protein, and fruit and vegetables are rich in minerals and vitamins.

Code
CARB
Pages 1–2

CARBOHYDRATES

1. Carbohydrates are nutrients.

2. Examples of carbohydrates are chemicals called sugars and starches.

3. Carbohydrates are mostly used for energy and in plants for building materials.

4. A 100-pound person has about 2 pounds of carbohydrates in body mass.

5. Carbohydrates are digested in the mouth and in the intestine.

6. During digestion starches are broken up into sugars.

7. Carbohydrates are carried in the blood as sugars.

8. Cells burn sugar to produce energy and extra sugar is changed into fat.

9. When sugars burn, water, carbon dioxide and energy are produced.

10. Foods rich in carbohydrates are breads, cereals, rice, noodles, potatoes, and candy.

11. Carbohydrates make up most of the non-water mass of fruits and vegetables.

12. It is recommended that between 55% and 60% of our food nutrients should be carbohydrates.

Code
PRO
Pages 1–2

PROTEINS

1. Proteins are nutrients.

2. Proteins are used in our bodies for energy, as building materials, and as regulators of the way our bodies work.

3. A 100-pound person has about 21 pounds of protein in body mass.

4. Proteins are digested in the stomach and intestines.

5. In digestion, proteins are broken up into chemicals called amino acids.

6. Amino acids are carried to our cells by our blood.

7. Our cells rebuild proteins to make new cells and maintain old ones. They also make hormones, digestive juices, and other chemicals that regulate our bodies.

8. Excess amino acid can be changed into fats. Excess amino acid is usually removed from our bodies as urine.

9. Foods rich in proteins are meats, eggs, beans, and nuts.

10. About 20% of our food nutrient should be protein.

Code
FAT **FATS**
Pages 1–2

1. Fats are nutrients.
2. Fats are used in our bodies as fuel, as building materials, and as a store of energy.
3. A 100-pound person has about 12 pounds of fat in body mass.
4. Fats are digested in the intestines.
5. In digestion, some fat is broken up into two chemicals called fatty acids and glycerine.
6. Fatty acids and glycerine are carried to our cells by our blood.
7. Cells called fat cells rebuild fat to store it.
8. Fat cells form great sheets of fat tissue that surround and protect organs such as the heart, lungs, and intestines.
9. Extra sugar and protein can be changed into body fat.
10. Fat is also burned to produce water, carbon dioxide, and energy.
11. Foods rich in fats are cooking oils, butter, margarine, nuts, and meat.
12. It is recommended that no more than 30% of our food nutrients should come from fat.

Code
MIN
Pages 1–2

MINERALS

1. Minerals are nutrients

2. Minerals are used in our bodies as building materials and in the making of body regulators.

3. A 100-pound person has about 5 pounds of minerals in body mass.

4. Minerals are digested in the intestines and carried to cells by the blood.

5. Our bodies need at least 14 different minerals.

6. Common minerals and some of their functions are
    - Calcium is used to build bones and teeth.
    - Chlorine is used to make digestive juices.
    - Magnesium is important in bone building and digestion.
    - Phosphorus is used to build bones and teeth and to help produce energy in cells.
    - Potassium is important to our nerves.
    - Sodium is important to our nerves.
    - Iron is used to carry oxygen in our blood.

7. Foods rich in minerals are dairy products, fruits, and vegetables.

Code
VIT
Pages 1–2

VITAMINS

1 Vitamins are nutrients.

2. Vitamins are used to regulate the way that our bodies work.

3. There are only tiny amounts of vitamins in our bodies.

4. Vitamins are absorbed in the intestines.

5. For good health our bodies need at least 20 different vitamins.

6. Common vitamins and some of their functions are
   - Vitamin A is necessary for healthy lungs, skin, vision, and digestion.
   - Vitamin B Complex is a group of vitamins necessary for healthy blood, nerves, and kidneys and other organs.
   - Vitamin C is necessary for healthy skin, bone, and muscle.
   - Vitamin D is necessary for healthy bones.
   - Vitamin E is necessary for healthy muscles and for reproduction.
   - Vitamin K is necessary for blood clotting and healthy digestion.

7. Foods rich in vitamins are dairy products, fruits, and vegetables

Code
WAT
Pages 1–2

WATER

1. Water is a nutrient.
2. Water is used in our bodies in digestion, to carry other nutrients to cells, to carry waste away, and to keep the right body temperature.
3. A 100-pound person has about 60 pounds of water in body mass.
4. Water is not a food.
5. Water is not broken up or digested. It goes directly into the blood from the intestine.
6. Water leaves our bodies in sweat, our breath, urine, tears, saliva, and in waste from digestion.
7. We lose 1 to 8 liters of water daily and this water must be replaced daily.
8. Sources of our water are found in the almost all the food we eat and the sugar, fat, and protein we burn to produce energy.
9. The heavier we are, the more exercise we do, and the hotter it is, the more water we need.
10. It is difficult to drink too much water.
11. Usually 6 glasses in winter and 8 in summer will be enough.
12. It is usually wise to drink when you are thirsty.

Name________________________

Date________________________

DASH

STUDENT PAGE 4.5.1 NUTRITION SECRET MESSAGES

1. Decode the messages that follow using the Nutrition Secret Message Code and Decoder Sheets. When the messages have been decoded, continue with Item 2.

2. Give your working definition for the term "nutrient."

3. Give your working definition for the term "organ."

4. Give your working definition for the term "tissue."

5. Give your working definition for the term "cell."

Name ____________________

6. What is meant by a food "rich in carbohydrates"?

____

____

7. List four foods rich in carbohydrates.

____

____

8. List four foods rich in proteins.

____

____

9. List four foods rich in fats.

____

____

10. List four foods rich in minerals.

____

____

11. List four foods rich in vitamins.

____

____

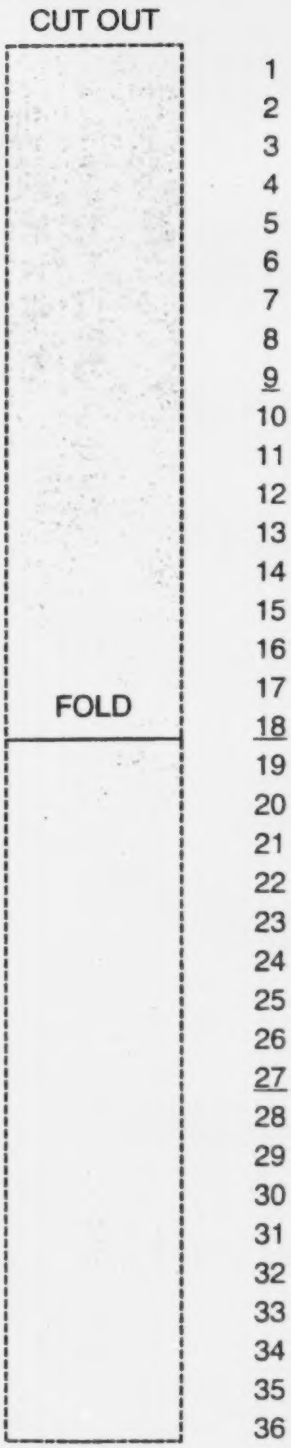
12. List four foods rich in water.

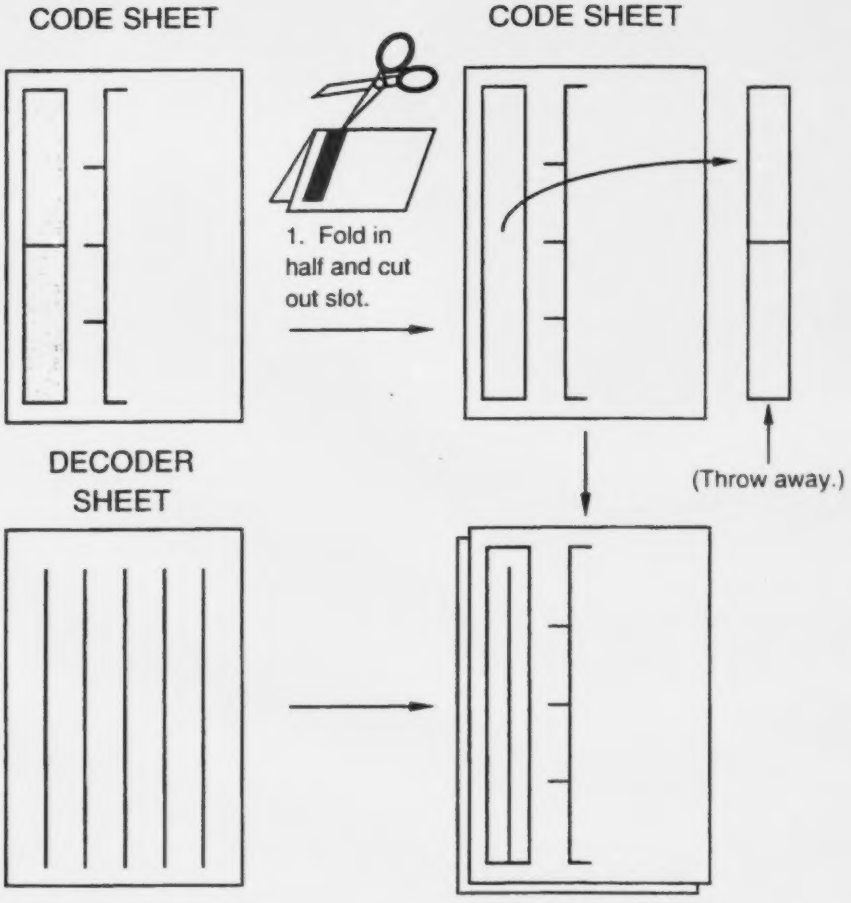
____

____

Name ______________________

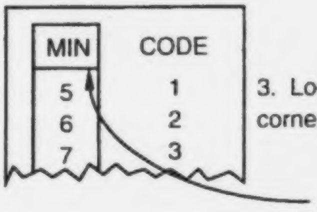
NUTRITION SECRET MESSAGE CODE SHEET


CUT OUT
FOLD
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

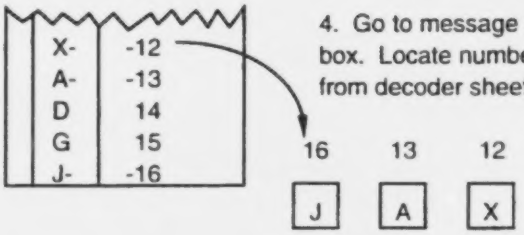

CODE SHEET
CODE SHEET
DECODER SHEET
(Throw away.)

1. Fold in half and cut out slot.

2. Place code sheet over decoder sheet.


MIN
CODE
5
1
6
2
7
3
code=mineral

3. Look on message sheet for code name in upper left corner. Slip code slot over the code name column.


X- -12
A- -13
D 14
G 15
J- -16
16
13
12
J
A
X

4. Go to message sheet; find code number above box. Locate number on code sheet. Read letter from decoder sheet.

Name ______________________

NUTRITION SECRET MESSAGE DECODER SHEET

CARB	FAT	PRO	MIN	VIT	WAT	TIS	OPT
1	9	7	5	4	8	2	3
9	7	5	6	3	9	8	0
6	5	2	7	6	5	9	1
5	3	3	1	8	6	3	4
4	1	4	0	9	1	5	7
3	2	1	3	5	0	1	2
2	4	8	4	0	2	4	6
7	6	9	8	7	7	0	9
0	8	6	9	2	3	7	5
8	0	0	2	1	4	6	8
W	C	F	L	A	K	C	E
Z	F	I	X	D	L	O	Q
K	I	L	A	G	J	G	T
H	L	X	D	E	B	E	J
E	0	A	G	H	S	Q	L
B	R	D	J	U	P	T	[illegible]
P	U	G	B	K	Y	M	H
M	X	J	E	Z	A	I	Z
J	A	M	H	M	D	P	B
G	D	P	U	I	N	A	S
U	G	S	V	N	Q	X	Y
R	J	B	Y	Q	T	J	C
0	M	E	K	T	M	L	K
L	P	H	W	C	I	D	M
C	S	K	Z	0	H	N	I
F	V	W	M	R	U	R	P
I	Y	Z	P	F	V	F	A
N	B	C	S	S	Z	K	0
Q	E	0	F	P	G	W	G
T	H	R	I	Y	E	H	D
Y	K	U	N	V	C	U	N
V	N	V	Q	W	0	V	R
S	Q	Y	T	L	R	Z	F
D	T	N	C	X	F	B	X
A	W	Q	0	J	X	S	[illegible]
X	Z	T	R	B	W	Y	V

Name ______________________

NUTRITION SECRET MESSAGES

Code
TIS
Page 1

TISSUES, CELLS, NUTRIENTS

12 24 18 35 17 20 14 31 19 19 26 16
1. Our B○○○E○ are ○○D○ ○○of○A○○S that we
12 26 20 25 30 14 26 16
call ○○G○○S. Examples of organs include our ○○A○○,
23 31 13 35 35 16 12 20 11 14 14
○○N○○, ○○○M○○H, intestines, ○Y○S, and legs.
19 23 36
Each organ ○○A○S a special role in our body. Our
30 14 26 19 17 19 23 25 13
○○A○T ○U○○S blood, our ○U○○S exchange
11 20 34 12 24 18 21 24
○○R○○N ○○O○I○E for oxygen.

17 20 14 16 18 31 14 35
2. Organs are ○○D○ of parts called ○○SS○○○ that are
20 24 14 11 23 23 35 14 23 23
M○○○ of other parts called ○E○○○ cells. C○○○S
31 25 18 16 35 23 18 32 13 16 30 18 25 13
are the ○○○○○ out of which ○○○IN○ ○○○○○S
35 25
are built. The cells in tissues can be ○EE○ only under a
17 18 11 12 11 12
○○○R○S○○PE.

17 31 35 23 14 35 30 20 18 26
3. Examples of tissues include ○○○C○○○, skin, ○○○○,
34 12 14 23 12 12
○○N○, nerves, and B○○○D.

Name ____________________

Code
TIS
Page 2

34 23 12 24 11 26 26 35 21 36 13 25
4. ○○○o○ is a tissue that ○A○○IE○ o○○○E○ and
31 16 26 18 14 16 35
N○○○○○N○○ to other tissues in our bodies. It carries
11 20 26 12 25 18 12 21 18 14 29 20 16 14
○○○B○○ D○○○○D○ and other ○○S○○ away from
23 31 13 35 13 18 14 35 31 19
tissues. In our ○○N○○, the blood ○○V○○ ○○ the
20 18 26
carbon dioxide to the ○○○. Other waste goes to the
28 18 24 25 36 35 14 17 12 32 23
○○○○E○○ for R○○○○A○ through the
19 26 12 14 35 31 26 18 20 16 18 12
○○○C○○S of ○○○N○○○○N.

27 12 24 35 23 18 18 25 13 16 30 18 13 35
5. ○○O○○ come from ○○V○○○ ○○○N○○ that are
17 20 24 14 16 35 31 14 34 31 18 23
also ○○○○ of ○I○S○○ and cells. Cells are ○○○○T
11 30 14 18 11 20 19 20 26 25 31 16 26 25 16 35
from ○○○M○○○L ○○○TS called ○○○○IE○○○.
24 18 13 35 16 18 12 19 26 12 11 14
In the ○○○E○○○○N ○○○○○SS cells are
34 26 12 28 14 25 24 12 29 25 16 26 14 25 16
○○○○○○○ ○○○N into ○U○○I○○○S. Our
12 24 18 14 34 31 18 23
B○○○○S are ○○○○T out of these nutrients.

35 18 21 19 26 16 18 25
6. ○○○ types of nutrients exist. They are ○○O○E○○S, fats,
11 20 34 12 30 24 26 20 14 35 29 20 16 14
○○R○○○Y○○○T○○, minerals, vitamins, and ○○○○R.

Name ______________________

34 12 18 14
7.Nutrients have three basic functions in our ○○D○○S.
27 18 35 16 27 31 14 23 20 11 16 32 20 14
○○R○○, they are used as ○○○○ to ○○○I○○T○our
34 25 18 35
○O○○E○.

35 14 11 12 25 24 11 30 17 18 11 23
8.○○○○○○, they provide ○○E○○○A○S to regulate our
13 26 12 18 13
bodily processes of ○○○W○N○, thinking, reproducing,
17 12 18 13 35 14 14 18 25 13
○○V○N○, breathing, ○○○○○○, and many more.

16 30 26 27 34 26 11 16
9.○○I○D, nutrients are used to ○A○○I○A○E or
34 18 23
○U○○D our bodies.

26 18 11 30 24 18 27 14 14 25
10.Different foods are especially ○○○○ in ○○F○○R○○T
19 12 20 12 14 26 18 11 14
nutrients. For example, ○○T○T○○S and ○○○○ are
11 20 26 12 30 24 26 20 16 35 34 31 16 26
especially rich in ○○○B○○Y○○○○E○. ○○T○E○
17 26 13 26 25 14 27 20 16 17 14 16
and ○A○○A○I○○are especially rich in ○○○, ○○A○
19 12 16 18 25 32 14 14 16 34 23 14 35
is rich in ○R○○E○○S, and fruits and○○G○○A○○○○
17 18 14 26 23 35 32 18 20 17 18 26
are rich in ○○N○○A○○ and ○○T○○○○S.

Name ____________________

Code
CARB
Page 1

CARBOHYDRATES

25 22 16 23 14 31 34 35 30 33 28 21 22 27 15 28 33
1. ○A○○○○○○R○○E○ are ○○T○○○○T○.

25 15 18 35 24
2. Examples of carbohydrates are ○H○○IC○○S called
33 20 22 33 30 25 14 15
○U○A○S and ○○AR○○○S.

21 33 15 34 16 23 27 15 33
3. Carbohydrates are mostly ○○○○ in our ○○D○○○ for
15 15 22 20 31 17 24 35 28 30 33
○N○○○○ and in ○○○○○○for
21 27 24 27 28
B○○○D○○G materials.

17 23 21 28 7 17 28 34 33
4. A 100-○○○○D person has about ○ ○OU○○○ of
18 35 33 33
carbohydrates in body ○○○○.

27 20 33 30 15 34 18 21 14
5. Carbohydrates are D○○E○○○○ in the ○O○T○ and in
27 28 15 30 27 28 15
the ○○T○S○○○○.

33 30 35 25 14 15 16 23 13 15
6. During digestion ○○○R○○○S are ○R○○○N
21 17 33 21 35 22
○○into ○○G○○S.

35 22 22 27 15 34 16 24 34
7. Carbohydrates are C○○○○○○ in the ○○OO○ as
21 20 35 22 33
S○○○○○.

626

Name ____________________

Code
CARB
Page 2

25 15 24 24 33 16 21 22 33 21 22 33
8. ○○○○○ ○○○N ○○GA○○ to produce
15 28 20 31 33 21 20 25 35 28 15 34
○○ER○○ and extra ○○○AR is ○H○○G○○ into
26 35 30
○○○.

16 21 28 11 35 22 25 35 23 28
9. When sugars ○○R○, ○○TE○, ○○RB○○
23 36 27 34 15 15 28 20 31
DI○○○○○, and ○○ER○○ energy are produced.

23 23 34 16 15 35 33
10. F○○○S rich in carbohydrates are ○R○○D○,
25 15 35 22 27 25 15 28 23 24 15 33
○ER○○LS, ○○○○, ○O○D○○○,
17 23 35 30 23 15 25 35 34 31
○○T○○○○S, and ○○N○○.

25 35 22 16 23 31 22 35 30 18 23 33 30
11. ○○○○○H○D○○○ES make up ○○○○ of the
18 33 33 26 21 27 30 33
non-water ○A○○ of ○R○○○○ and
32 15 30 35 16 24
○○GE○○○○ES.

22 15 25 18 34 15 34
12. It is ○○○OM○EN○○○ that between 55% and 60% of our
26 23 34 28 21 22 27 15 28
○○O○ ○○T○○○○TS should be carbohydrates.

SP 4.5.1—10

Name ____________________

Code
PRO
Page 1

PROTEINS

20 29 23 12 34 34 31 30 23 36 21
1. ○R○T○○○S are ○○T○I○N○○.

30 36 34 21 31 21 16 22 16 23
2. P○O○EI○○ are ○○E○ in our ○O○I○S for
23 23 17 33 22 13 16 34 17
○N○R○○, as ○UI○○I○○ materials, and as
30 23 13 36 16 29 30
○○GU○A○○RS of the way our bodies W○○K.

6 10 10 31 34 16 3 3 20 29 16
3. A ○○○-PO○○○ person has about ○○ ○○UN○S of
19 15 21 21
protein in body ○○○○.

16 17 21 36 16 21 19 15 28
4. Proteins are ○I○E○○E○ in the ○TO○○○H and
12 36 21 36 34 23 21
○N○E○○I○○○.

16 17 23 21 12 22 29 23 34 31 20
5. In ○I○○○T○ON, proteins are ○R○K○○ ○○ into
24 23 12 15 13 21 19 34 29 15 12 16
C○○M○C○○○ called A○I○○ ○C○○S.

15 12 29 28 12 21 23 13 21
6. ○M○N○ A○○D○ are carried to our C○○L○ by our
22 29 16
○L○O○.

Name ______________________

Code
PRO
Page 2

28 13 21 20 29 36 12 34 23 26
7. Our ○E○L○ rebuild ○R○○E○NS to make ○○○
28 13 13 21 19 15 36 15 12
○E○○○ and ○○IN○○○N old ones.
24 30 29 34 21 12 17 36 12 32 23
They also make ○O○M○○E○, D○○ES○○○○
18 12 23 21 28 23 19 12 15 21
○U○C○○, and other ○H○○○C○L○ that
30 23 13 36
○○GU○A○E our bodies.

28 23 21 21 15 12 34 15 12 16
8 EX○○○○ ○M○○O ○C○○S can be changed
11 15 21 23 23 21 15 19 34 29 28 12
into○○T○. ○XC○○S ○○I○○ A○○D is
30 19 29 23 31 12 34 23
usually ○E○○V○D from our bodies as ○R○○○.

29 29 16 30 28 19 15 36 21 17 21
9. F○○○S ○I○H in proteins are ○E○○○, E○G○,
22 15 21 34 36 21
○E○N○, and ○U○○.

22 29 31 3 10 11 29 16 31 36 12 23 34 36
10. A○○○T ○○% of our ○○O○ N○○R○○○○ should
20 36 23 12
be ○RO○○○N.

Name ____________________

Code
FAT
Page 1

FATS

12 34 25 32 17 34 16 29 32
1. ○A○○ are ○○○○I○○TS.

19 34 15 20 13 29 12 29 14
2. F○○S are used in our B○○○○S as ○U○○, as
28 17 20 13 32 21 25 15 16 29
○○IL○○○○ materials, and as a ○T○○○ of
32 29 21 27
E○○R○○.

5 10 10 24 15 17 32 20 5 6
3. A ○○○ ○○○○○ person has about ○○
15 17 32 20 23 19 25 25
P○○○○S of fat in body ○○○○.

20 13 21 25 29 20 13 32 34 34 13 32 29
4. Fats are ○○○E○T○○ in the ○○○ES○○○○S.

13 21 29 25 15 32 16 15 31 29 17 24
5. In D○○○○TI○○, some fat is B○○○○N ○○into two
12 34 34 11 20 21 29 16 13 32
chemicals called ○A○○Y A○I○S and ○LYC○○○○E.

19 34 27 19 11 20 25 14 11 29 13 29
6. F○○T○ ○○I○○ and G○Y○○R○N○ are carries to
11 29 14 25 28 14 15 15
our ○○L○○ by our ○○○○D.

12 19 34 11 14 14 34 15 16
7. Cells called ○○○ ○E○○S rebuild fat to S○○○E it.

Name ____________________

Code
FAT
Page 2

11 14 25 30 29 29 34 19 34 13 25 25
8. Fat ○EL○○ form great S○○○○S of F○○ T○○○UE
24 15 34 29 11 16 21 19 32 25
that surround and ○R○○○○T O○○○○○ such as the
30 29 16 34 14 17 21
○○A○○, ○○N○S and intestines.

17 21 16 24 16 34 29 13
9. Extra S○○A○ and ○○O○○○N can be changes into
28 15 27 19 34
○○D○ F○○.

28 17 16 29 35 34 29 11 16 28 15
10. Fat is also ○○○N○D to produce ○A○○R, ○A○○○N
20 13 18 13 20 29 32 16 21
○○O○○○E, and ○○E○○Y.

12 15 20 25 16 13 30 11 15 15 13 32 15 13
11. ○O○○○ ○○C○ in fats are ○○○K○○G ○○LS,
17 34 29 16 23 16 19 16 13 32 29 29 19
B○○T○○, ○A○G○○○○○, nuts, and M○○T.

11 23 23 29 32 20 4 10
12. It is RE○O○○○○DE○ that no more than ○○% of our
12 15 17 34 13 29 32 25
○○OD N○○R○○○T○ should come from fat.

Name ________________________

Code
MIN
Page 1

MINERALS

26 31 18 13 11 / 31 33 36 18 33 28
1. ○I○○R○○S are ○U○○I○N○○.

30 18 36 11 28 / 20 28 14
2. M○N○○A○○ are ○○E○ in our bodies as
17 30 11 14 31 15 / 26 23 30 15
○U○○○I○○ materials and in the ○A○○N○ of body
18 15 11 13 36 28
R○○U○○TO○○.

4 5 5 27 35 31 / 1 / 35 20 14
3. A ○○○-○○U○D person has about ○ P○○N○S
26 31 18 36 11 28
of ○I○○○A○○ in their body mass.

14 30 18 33 18 14 / 30 33 18 30 31 28
4. Minerals are ○○G○S○○○ in the ○N○○ST○○E○
18 11 11 / 17 35 35
and carried to C○○○S by the ○L○○D.

31 18 14 / 4 7 / 14 29 36 18 31 33
5. Our bodies ○○E○ at least ○○ ○IF○E○○○○
26 30 31 13 28
○○○ER○L○.

35 / 35 31 / 26 31 18 13 11
6. C○MM○○ ○I○○R○○S and some of their functions are

13 34 30 20 / 17 31 28 / 33 18 33
- C○L○○○M is used to build ○O○E○ and ○○E○H.

34 11 35 30 31 / 30 15 / 33 21 18
- ○H○○R○○E is used to make D○○ES○I○ ○
16 30 18 28
○U○C○○.

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Name ______________________

Code
MIN
Page 2

13 31 18 30 20 26 17 31 18
• M○G○○S○○○ is important in ○O○○ building and

14 30 18 28 33 35
○○G○○○I○N.

35 28 19 35 36 28 35 31 18
• PH○○P○○○U○ is used to build B○○○S and

33 18 19 18 18 15
○E○T○ and to help produce ○N○R○Y in cells.

35 13 28 28 20 26 18 36 21 28
• P○T○○○I○○ is important to our N○○○E○.

28 14 20 31 18 18
• ○O○I○M is important to our ○○RV○S.

36 31 35 12 22 15 31 11 35 14
• I○O○ is used to carry ○○○○E○ in our B○O○○.

29 35 28 36 34 13 36
7. ○O○D○ ○I○H in minerals are D○I○Y dairy

27 14 34 33 29 20 30 33 28 21 18 18 17 11 18 28
○RO○U○○S, ○R○○○○, and ○○G○TA○○○○.

Name ______________________

Code
VIT
Page 1

VITAMINS

31 23 20 21 28 16 23 20 14 23 28
1 ○I○AM○○○ are N○○R○○N○○.

20 11 19 20 21 16 28 14 26 13 33 11 14
2. V○T○○○○S are ○○○D to ○E○U○○T○ the way
32 26 17
that our bodies ○O○○.

20 21 11 25 21 23
3. There are only T○○Y ○M○U○○S of vitamins in our
36 25 20 14
○○D○○S.

11 36 28 25 26 36 14 12 20 21 14 23 20 21
4. Vitamins are ○○○○○○○○ in the ○○T○S○○○E.

15 11 23 15 14 12 9 7
5. For good ○E○L○○ our bodies N○E○ at least ○ ○
12 20 27 14 23
○○F○ER○N○ vitamins.

25 19 25 31 20 23 20 21 28
6. C○M○○N ○○○AM○○○ and some of their
16 21 20 25 21
F○○CT○○○S are

11 16 21 13 28 28 20 21
- Vitamin ○ is necessary for healthy L○○○○, ○K○○,
  31 28 25 21 12 13 23 20 21
  ○I○I○○, and ○I○ES○○○O○.

Name ______________________

Code
VIT
Page 2

36 24 19 33 14 34 13 16 29
- Vitamin ○ ○O○P○○○ is a ○RO○○ of
31 20 19 20 21 28 33 25
○○TA○○○○ necessary for healthy B○O○D,
21 26 14 17 21 30 26 11 21 28
○E○V○S, and ○ID○E○S and other O○G○○○.

24 15 11 23 15 30 28 17 21
- Vitamin ○ is necessary for ○E○L○○○ ○○I ○,
36 21 19 28 33 14
○O○E, and ○U○C○○.

12 36 25 14
- Vitamin ○ is necessary for healthy ○○N○S.

14 16 24 33 14
- Vitamin ○ is necessary for healthy M○S○○○S and for
26 26 25 16 24 20 25
○EP○○D○○T○○N.

17 36 33 25 25 24 25 23 20 21
- Vitamin ○is necessary for ○○○○D ○L○○T○○G
20 13 23 25
and for healthy D○○ES○I○N.

25 12 28 26 24 12 20 30
7. FO○○○ ○I○H in vitamins are ○A○R○
29 25 12 24 28 27 20 31 13 14 36 33 14
○R○○U○T○, ○RU○TS, and ○E○○TA○○○S.

Name ______________________________

Code
WAT
Page 1

WATER

36 22 33 26 22 30 20 22
1. ○A○E○ is a N○○RI○○○.

36 18 30 26 15 30 24 29 22 32 20
2. ○○T○R is ○○○D in our bodies in D○○ES○I○○, to
20 33 24 30 22 15 31 30 12 15
carry other ○UT○○○N○○ to ○○○L○, to carry
18 22 30 24 29
W○S○○ away, and to keep the R○○HT body
30 23 33 22 26 30
T○○PE○A○○R○.

5 6 6 32 26 19 4 6 16 26 20 19 15
3. A ○○○-P○○N○ person has about ○○ ○O○○○○ of
36 18 22 30 18 15 15
○○○○R in body M○○○.

36 30 33 32 22 32 32 19
4. ○AT○○ is N○○ a F○○○.

18 22 30 33 20 32 32 11 20 26 16 19 29 15 30 19
5. W○○○○ is ○○T BR○○E○ ○○ or ○I○E○T○○.
19 33 22 12 14 32 32
It goes ○I○EC○○Y into the ○L○○D from the
24 30 15 24 20
○NT○○T○○E.

18 22 30 33 18 27 30 15 15 30 18
6. W○○○○ LE○○○○ our bodies in ○W○○T, our
33 30 18 26 24 30 30 18 15 18 12 24 18
B○○○TH, ○R○N○, T○○R○, S○○○V○, and in
36 15 30 24 30 15 22 24 32
○A○T○ from D○G○○○○○N.

Name ____________________

Code
WAT
Page 2

32 15 30 5 1 12 30 33 15 36 18 30 19 12 17
7. We L○○○ ○ to ○ ○IT○○○ of ○○T○R ○AI○○
36 30 33 33 30 18 30 19 24 12 17
and this ○AT○○ must be ○○PL○C○○ DA○○○.

32 26 33 31 30 15 36 18 22 34 26 20
8. S○○○○○○ of our ○○○ER are ○O○○D in
12 32 15 22 34 32 19 30 22
A○M○○○ all the ○○O○ we ○A○ and the
15 18 33 34 18 22 16 33 30 24 20 26 33
○UG○○, ○○○, and ○○OT○○○ we B○○N to
16 19 26 31 30 20 29 17
○RO○○○E ○○ER○○.

25 30 24 30 30 30 31 24 15
9. The ○○AV○○R we are , the more ○X○R○○○E
25 32 22 30 23 30
we do, and the ○○T○○R it is, the ○OR○
20 19
water we ○EE○.

19 34 34 24 26 12 23 31 25
10. It is ○I○○○C○○T to get too ○U○○much
36 22 30 33
○A○○○.

15 26 18 12 29 15 15 30 15 36 20 22 30
11. U○○○○LY 6 ○LA○○○○ in ○I○○○R
15 26 23 20 26 29 25
and 8 in ○○M○ER will be E○O○○○.

19 24 20 22 24 15 17
12. It is usually wise to ○R○○K when you are ○H○R○T○.

ACTIVITY 4.5.2 MECHANICAL DIGESTION

OBJECTIVES

The students
- Make a concept map about digestion.
- Simulate what happens during digestion.

BACKGROUND

This activity should follow Activity 4.3.21 LENGTH OF THE DIGESTIVE TRACT and 4.5.1 NUTRITION MESSAGES. In MECHANICAL DIGESTION the students simulate what happens in the process of digestion.

Simulation

Each of the body's major organs of digestion is simulated. A stick is the tongue; a pestle and mortar (or food chopper), the teeth; a funnel, the throat; a balloon, the esophagus; a surgical glove, the stomach; a paper towel tube, the intestine and anus; and a bowl, the body cavity.

Foods

Use soft, juicy fruit, sugar, crackers, and whatever else you choose. Be sure to use lots of water.

Acid

The stomach uses dilute hydrochloric acid to dissolve foods. In this activity vinegar is substituted for hydrochloric acid so that the students can safely taste the liquid. Dilute the cooking vinegar (acetic acid) using one part vinegar to three parts water.

STUDENT ROLES

Physiologist
Physician

MATERIALS

Pestle and mortar
Stick (a Popsicle stick, wooden chopstick, or narrow rubber spatula)
Large funnel
Wide-diameter long balloon (not the type used for making shapes) or Tygon plastic tubing that will fit over the end of the funnel
Rubber band to hold balloon on the funnel
Scissors
Surgical glove
Sugar
Bulldog clamp (optional)
Crackers
Fruit
Paper towels
Bowls (2)
Water
Acid solution (1/4 cup vinegar and 3/4 cup water)
String
Student Page 4.5.2 MECHANICAL DIGESTION SIMULATION

PRODUCTS

Digestion Concept Map
Model of the digestive system
Completed Student Pages

PROCEDURES

1. **Have the students create a concept map about digestion.**

   Include such ideas as
   - Body parts involved.
   - Actions of parts.
   - Functions of parts.

2. **Explain that since we cannot get into the body to see how it works, we will simulate the functions of the digestive tract. Emphasize that this model of digestion will give some idea of what happens in our bodies.**

3. **Assign 7 students to represent and simulate a part of the digestive system. See Figure 4.5.2.**

   After the students receive their assignments, ask them to describe the part of the digestive tract they represent. Have them arrange themselves in the sequence of the organs of the digestive tract. The student operating a specific mechanical device acts as an organ of digestion.

   - *First student with a PESTLE AND MORTAR to represent the* ***mouth and teeth***. Be sure the pestle and mortar have not previously been used with chemicals.
   - *Second student with a STICK to represent the* ***tongue***.
   - *Third student with a FUNNEL to represent the* ***throat***.
   - *Fourth student with a BALLOON OR TUBING to represent the* ***esophagus***. Attach the balloon or tubing to the end of the funnel. Secure the exit end of the tubing or balloon by holding it tightly or clamping it with a Bulldog clamp.
   - *Fifth student with a RUBBER GLOVE to represent the* ***stomach***. Prepare the glove beforehand as shown in Figure 4.5.2.
   - *Sixth student with a PAPER TUBE to represent the* ***small intestine***. The tube can be made from strong paper toweling.
   - *Seventh student with a BOWL to represent the* ***body cavity*** *and its distribution network.*
   - Have a second container available on the side to represent the toilet. It is not advisable to assign a student to this role.

4. **Provide a simulated lunch of fruit, crackers, and sugar. Comment that this is not a good lunch, but it is what our model ate. As the students carry out the simulation, emphasize the function of each part of the system.**

5. **Review with the students what happens to food in their mouths. Establish that food is ground up (mechanical action) and made into a paste with the help of saliva (chemical action). Have the first student grind food with the pestle and mortar (mouth and teeth). Add a little water to help make the lunch into a paste.**

Ask such questions as
- What happens to food in our mouth?
- What mechanical action helps in digestion?
- What chemical action helps in digestion? (The chemical in saliva called **ptyalin** begins the digestion of starch.)

6. **Ask the students to explain how the food gets into our throat. Once the role of the tongue is agreed upon, have the second student use the stick (tongue) to push the food mass into the funnel (throat) operated by the third student. Add water as needed.**

7. **Have the students identify the tube behind the throat.**

   Ask such questions as
   - How might food be pushed down the esophagus? (Have the students recall what happened when the food was "eaten.")
   - How did the food move to the stomach?

8. **Have a fourth student demonstrate how food can be moved downward by squeezing the esophagus (a mechanical action called *peristalsis*). Cut a hole at the end of the balloon and have the fifth student operating the stomach be ready to receive the contents. If tubing is used, remove the clamp.**

9. **Have the students explain where the food goes next.**

   - Ask the students what happens in our stomach. Point out that in the stomach the food is mixed with acid digestive juices, chemicals in water that further break up food.
   - Add a cup of vinegar solution to the glove. Have the students close the glove with string and squeeze and slosh the simulated stomach to mix the lunch with the acid solution.

10. **When the lunch feels well mixed, ask where the food goes next.**

    - After the intestine is identified, open the valve, which corresponds to the pyloric valve at the intestine end of the stomach, and empty the liquid mass into the paper tube.
    - Have the sixth student hold up both ends of the simulated intestine so that the liquid will filter out of the tube through the middle. Be sure that the tube is suspended above the bowl.

11. **Have the seventh student hold a bowl to catch the liquids absorbed into the bloodstream which carries the digested nutrients to the body tissues. Have the student taste the liquid that filters into the bowl.**

    - Ask the student to describe the taste. (Sweet primarily, but the vinegar taste may be noticeable.)
    - Ask the other students what has happened to the cracker, sugar, fruit, and acid solution. (Work to the idea that the food has been broken down into nutrient chemicals that enter the blood and pass through the wall of the intestine. The blood carries the nutrients to all parts of the body.)

12. **Ask the students where the undigested food goes. Have the sixth student demonstrate that by the same kind of contractions found in the esophagus, waste (undigested food) is moved out of our bodies through the anus. Have a second bowl ready to receive the simulated feces.**

13. **Have the students use Student Page 4.5.2 MECHANICAL DIGESTION SIMULATION to summarize the activity.**

EXTENSIONS

Have the students

- Pretend that they are food and write a play or poem about what happens to them, including their feelings as they move down the digestive tract.
- Make life-size outlines of each other on butcher paper. Have them sketch in their digestive tract and write in the names and functions of each of the organs.

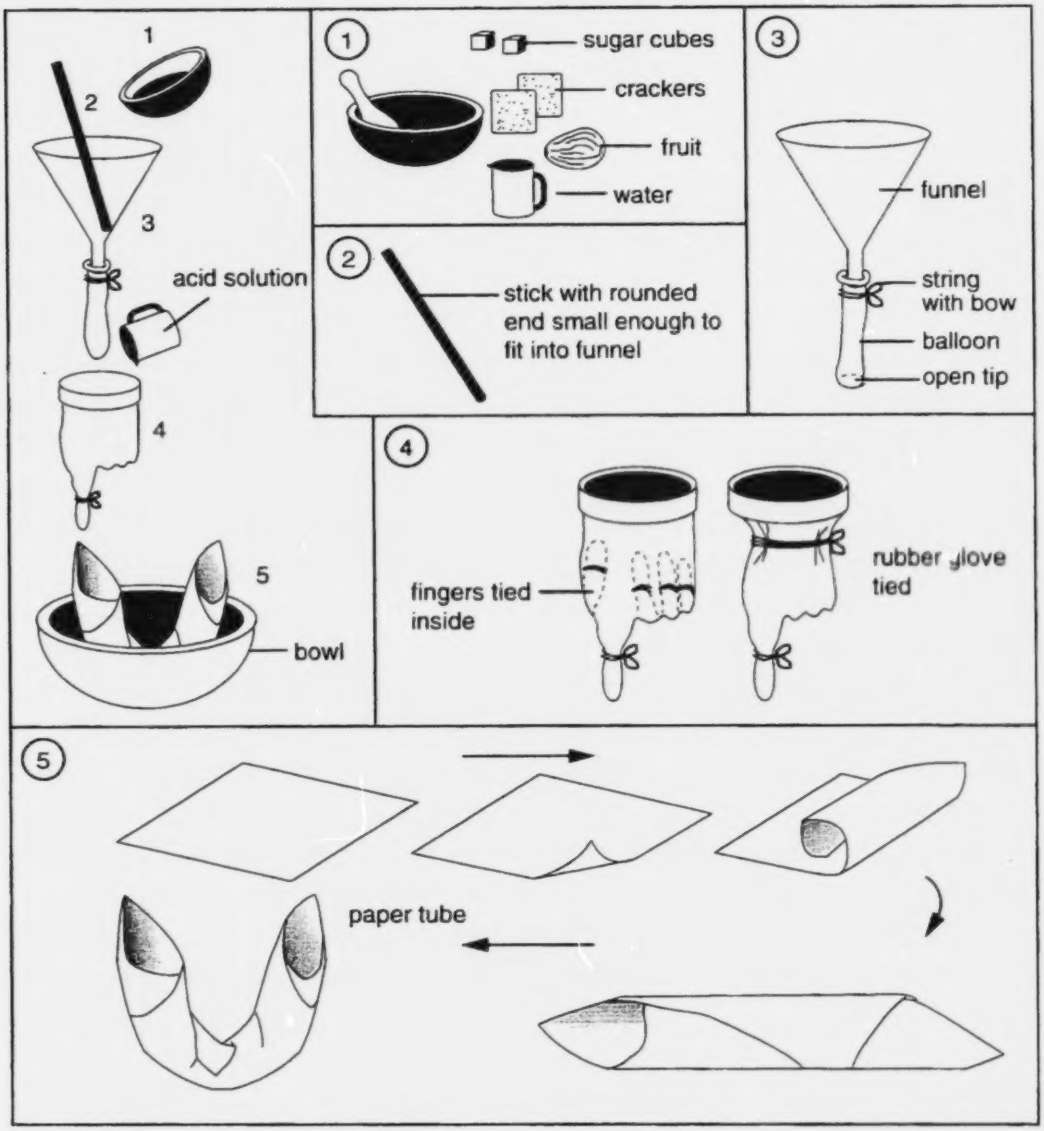

1
2
3
acid solution
4
5
bowl
①
sugar cubes
crackers
fruit
water
②
stick with rounded end small enough to fit into funnel
③
funnel
string with bow
balloon
open tip
④
fingers tied inside
rubber glove tied
⑤
paper tube

Figure 4.5.2 Setting up a mechanical digestion simulation

Name______________________

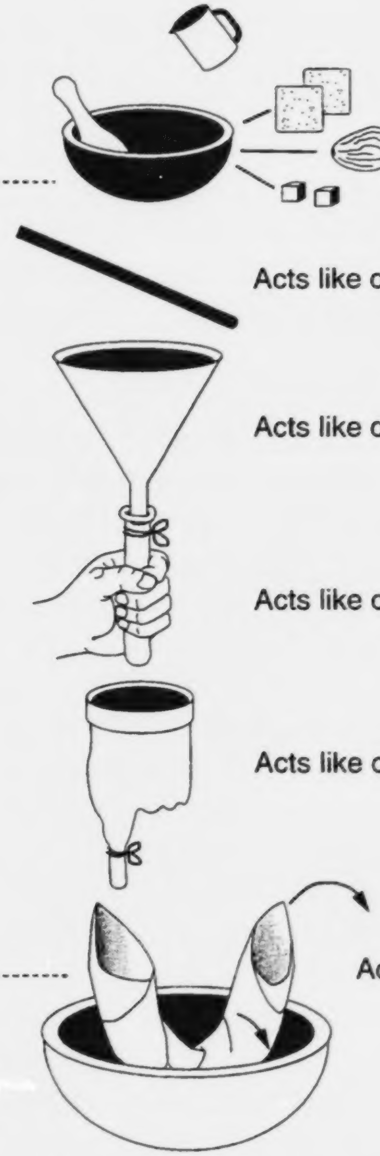
Date______________________

STUDENT PAGE 4.5.2 MECHANICAL DIGESTION SIMULATION

FILL IN THE BLANKS WITH THE NAMES OF THE ORGANS LISTED IN THE BOX

ORGANS

- anus
- esophagus
- intestine
- mouth
- tongue
- stomach
- throat



Acts like our ....

Acts like our ....

Acts like our ....

Acts like our ....

Acts like our ....

Acts like our ....

Acts like our ....

Figure SP4.5.2 Setting up a mechanical digestion simulation

ACTIVITY 4.5.3 CHEMICAL DIGESTION

OBJECTIVES

The students
- Observe the effect of acid on foods rich in fat, carbohydrate, and protein.
- Practice using the pH scale to analyze reaction of food and acid.

BACKGROUND

This is the third activity in the digestion sequence. It should follow Activity 4.5.2 MECHANICAL DIGESTION and precede 4.5.4 FOOD GROUPS. In CHEMICAL DIGESTION the students get a sense of how chemicals in the digestive tract operate by observing how acid helps in the digestion of foods. They mash samples of food, put them in plastic bags with acid, and then observe them. Food from their lunch can be used. The students observe how decomposition of foods changes the pH.

Acid

Use undiluted vinegar straight from the bottle to simulate stomach acid. Vinegar is acetic acid, but it will react the same way with foods as hydrochloric acid, the acid found in the stomach. Make sure everyone wears eye shields and aprons when handling acids.

Use Hydrion pH test strips to measure the strength of the acid as it reacts with the food. The students will observe that as acid reacts, the pH gets closer to 7.

STUDENT ROLES

Physiologist
Chemist

MATERIALS

Acetic acid (vinegar)
Resealable plastic bags
Graduated volumetric containers
Jars to hold the acid
A food rich in protein (egg, meat, cheese)
A food rich in carbohydrate (bread, spaghetti, potato)

A food rich in fat (butter, fat from meat)
Aprons
Eye shields
Hydrion pH test strips with wide-range pH
Student Page 4.5.3 CHEMICAL DIGESTION

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Have the students get foods rich in fat, protein, and carbohydrate from their school lunches.**

   Ask such questions as
   - What foods from your lunch would be rich in carbohydrate? (Work to such foods as bread, potatoes, and rice.)
   - What foods from your lunch would be rich in fat? (Get at such foods as butter and margarine.)
   - What foods from your lunch would be rich in protein? (Work to such foods as meat and eggs.)

2. **Point out that in addition to mechanical breakup, food is also digested by chemicals. One of these chemicals in the stomach is hydrochloric acid.**

   Ask such questions as
   - How could we watch what happens to food that is mixed with acid? (Work to the idea of putting the food mixed with acid into plastic bags or baby food jars.)
   - What form would the food be in when it reaches the stomach? (Work to the idea that it would be chewed up.)
   - How can we test the strength of the acid that we are using? (Help the students recall the use of Hydrion pH test strips.)
   - What would happen to the pH of the acid as the acid is used up? (Get at the idea that the pH will get larger, going toward 7.)

3. **Have the students work in groups to set up the experiment. Be sure they wear eye shields and aprons. Have them report their observations on Student Page 4.5.3 CHEMICAL DIGESTION.**

Have the students

- Pour undiluted acid into a container and record its pH.
- Select one food rich in fat, one rich in protein, and one rich in carbohydrate.
- Mash the food as it would come from the mouth.
- Put half a teaspoonful of each mashed food into two plastic bags.
- Pour 20 mL of undiluted acid into the bags.
- Observe the acid's interaction for two or more days.

4. **Summarize what happens in the bags.**

Ask such questions as

- What foods, if any, show any evidence of change or breakdown by the acid? (Meat will show some decomposition or "digestion," and other foods will lose their color.)
- Do any of the foods seem to be unaffected by the acid? Which ones? (Fats and carbohydrate foods will show little decomposition.)
- How could we summarize what seems to happen to food as it reacts with acid in the stomach? (Acid seems to react with protein.)
- What was the pH of your acid before the reaction?
- What was the pH after the reaction?
- What seems to happen to the acid as it reacts with food? (Get at the idea that it seems to get weaker; the pH becomes nearer 7, the pH of pure water.)

EXTENSIONS

- Have the students find out what other chemicals are involved in digestion.

Name__________________________

Date___________________________

DASH

STUDENT PAGE 4.5.3 CHEMICAL DIGESTION

Record the name of each food beside its food type. Record any observations and the pH before and after the simulated digestion.

FOOD TYPE	FOOD TESTED	OBSERVATIONS	pH BEFORE	pH AFTER
Carbohydrate				
Fat				
Protein				

ACTIVITY 4.5.4 FOOD GROUPS

OBJECTIVES

The students
- Explore the Food Guide Pyramid system of food classification.
- Compare the Activation, Regulation, and Fabrication and the Food Guide Pyramid food classification systems.
- Find out how many servings in each food group of the Food Guide Pyramid are found in the school lunch.

BACKGROUND

This is the fourth activity in the digestion and nutrition sequence. It is preceded by Activities 4.5.1 NUTRIENTS, 4.5.2 MECHANICAL DIGESTION and 4.5.3 CHEMICAL DIGESTION and is followed by Activity 4.5.5 THE DIGESTION GAME. FOOD GROUPS introduces the Food Guide Pyramid system and compares it with the DASH Activation, Regulation, and Fabrication (ARF) system. If the students have no background in DASH, do Activity 3.5.1 FOOD SELECTION, Procedures 1–5, before FOOD GROUPS.

In June of 1992 the U.S. Department of Agriculture announced a new guide to daily food choices called the Food Guide Pyramid system. See Student Page 4.5.4A FOOD GUIDE PYRAMID. The Food Guide Pyramid system divides foods into six groups. Five groups are considered to be healthful foods with recommended daily servings. One group is to be used only sparingly. Fats, oils, and sweets fall into this category. The total number of servings of foods per person per day suggested in the Food Guide Pyramid system range from 15 to 26, providing 1600 to 2800 kilocalories of energy.

In this activity the students compare the ARF system and the Food Guide Pyramid system. They find that each of the categories in the ARF system have been split into two categories in the Pyramid system. The Activation Group of the ARF system contains the same foods as the Bread and Cereal Group and the Fats and Sweets Group of the Pyramid system. The Regulation Group contains the same foods as the Fruit and the Vegetable Groups of the Pyramid system. In the Pyramid system the foods of the Fabrication Group are divided between the Dairy Product and Meat Groups.

The students should note that the ARF grouping is built around **food functions** and the Food Guide Pyramid system around **kinds of foods**.

Before starting this activity, talk to your food service manager so that food service workers can be prepared to answer questions about foods and food serving size.

STUDENT ROLE

Nutritionist

MATERIALS

Student Pages	4.5.4A FOOD GUIDE PYRAMID 4.5.4B FOOD GROUPS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Explain that the activity will involve looking at the U.S. Department of Agriculture food selection guide found in Student Page 4.5.4A FOOD GUIDE PYRAMID. Have the students review the Activation, Regulation, and Fabrication (ARF) food group system by completing Item 1 of Student Page 4.5.4B FOOD GROUPS.**

2. **Have the students examine the new Food Guide Pyramid system and complete Student Page 4.5.4B. Help them compare the two systems.**

   Ask such questions as
   - The Activation Group is similar to which of the groups of the pyramid? (Get agreement the same foods are found in the Bread and Cereal Groups and the Fats and Sweets Groups.)
   - The Regulation Group is similar to which of the groups of the pyramid? (Get agreement the same foods are found in the Fruit and Vegetable Groups of the Pyramid system.)
   - The Fabrication Group is similar to which of the groups of the pyramid? (Get agreement the same foods are found in the Meat and Dairy Product Groups.)
   - What are the differences in the two systems? (Each of the groups of the ARF system have been broken up into two categories.)

- What kind of categories are used in the Pyramid system (Get agreement that these are **kinds of foods.**)
- What kind of categories are used in the ARF system? (Get agreement that these are the **functions** of foods, or what they do for us.)

3. Discuss the logic for dividing the groups

Ask such questions as

- Why might we divide the Activation Group into two groups? (Work for such ideas as we need to have a concern for the amount of fats and sweets we eat as we grow older. Excess fats may over the years lead to coronary heart disease and other diseases. Current guidelines call for no more than 1/3 of our daily food intake to be fat.)
- Why might we divide the Fabrication Group into two groups? (Work for such ideas as though milk products contribute to all of our body needs, their most important contribution is in minerals, especially phosphorus and calcium. The meats are particularly rich in protein for muscle building.)
- Why can't we use milk and its products as our sole source of nutrients? (Get at the idea that as we grow, we need larger quantities of nutrients and there are many foods that are much more concentrated in nutrients than milk which is mostly water. Some people become allergic to lactose in milk as they grow older and find other sources of calcium such as tofu or they take tablets to counteract the reaction to lactose.)
- Why might we divide the Regulation Group into two groups? (Work for such ideas as fruits are particularly rich in vitamins and vegetables are particularly rich in minerals. By having two groups we are more likely to select both vegetables and fruits, which gives us better chance of getting a balanced diet.)

4. Have the students make a list of as many foods as they can think of that have fat and sugar in them. Have them use Student Page 4.5.4B, Items 3 and 4.

Ask such questions as
- What foods did you find that have fats in them?
- In which of the groups of the Pyramid system are fats found? (Fats will be found in all of the other five groups of foods though they are far less abundant in fruits and vegetables.)
- What foods do you find that have sugar in them?
- Which of the groups of the Pyramid system does sugar fit? (Sugar will be found in all plant-derived food and in milk products.)
- Why do you think that fats, oils, and sweets are singled out to be used sparingly? (Get at such ideas as they are already found in abundance in other food groups. Fats in particular can produce heart problems and overweight. Because extra sugar is converted to fat for storage in our body, an excess can lead to weight problems.)

5. **For several days have the students record the number of servings of each food group they receive in their school lunch.**

Have the students
- Ask the food service personnel how many servings they are getting of each food item.
- Ask about the group of food when there is a question.
- Record their findings on Student Page 4.5.4B FOOD GROUPS.

6. **Summarize the data taken on school lunches.**

Ask such questions as
- Which of the food groups were found in the lunch?
- How many servings of each group did you receive?
- Does everyone agree?
- What was the serving size for each group (full cup, half a cup, spoonful, other)?
- Does everyone agree?
- What fraction of the suggested servings of the pyramid did you receive? (This will be about 1/3 of the mid range of the guidelines, someplace between 6 and 8 servings.)
- Does everyone agree?
- Why do you think this fraction is served? (Get at the idea that one meal is 1/3 of the number of meals most people have each day.)
- How varied are the foods served from day to day?

- Why should we have a wide variety of foods in our meals? (Work toward the idea that we need to make sure we receive all of our nutrients and different foods have different concentrations of nutrients.)

EXTENSIONS

Invite the school food service manager to explain

- How the amount of food that must be prepared daily is calculated.
- How each person is provided with the proper serving size.
- How the menu is made up.
- How the school lunch is financed.

Name______________________________

Date______________________________

STUDENT PAGE 4.5.4A FOOD GUIDE PYRAMID

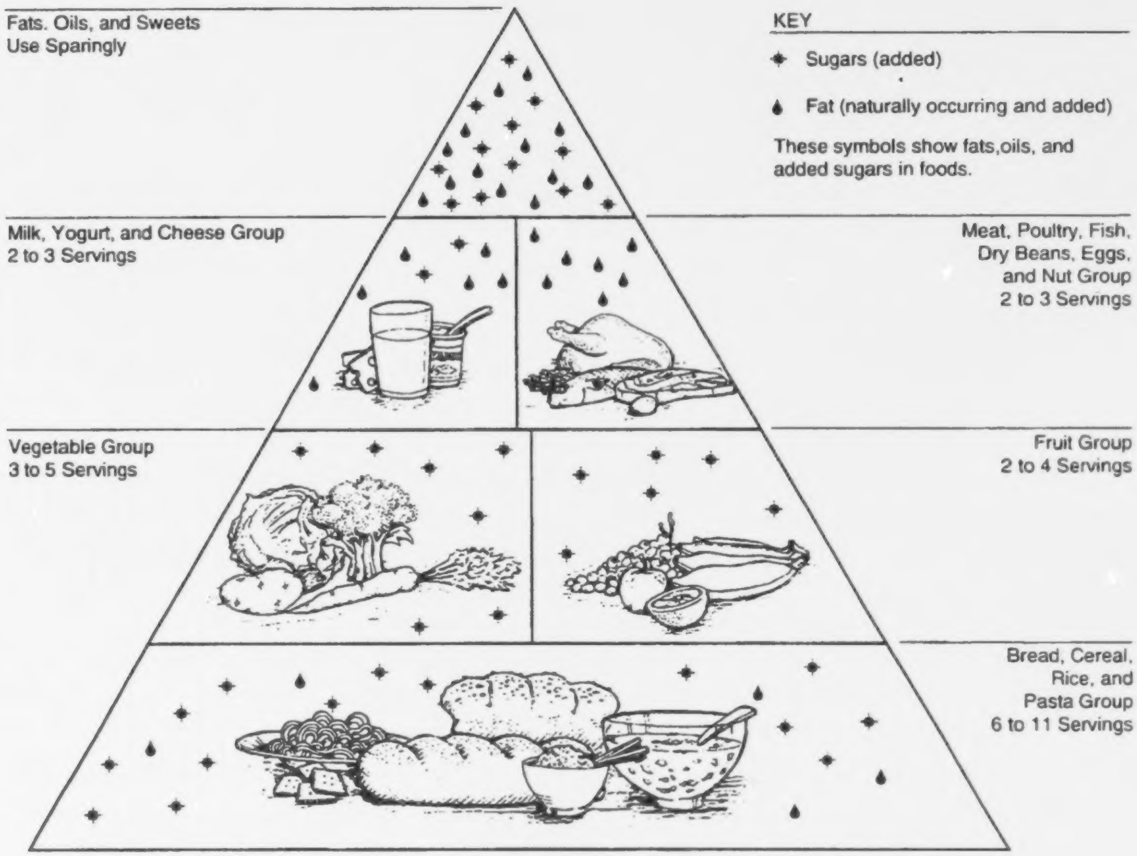

Fats. Oils, and Sweets
Use Sparingly
KEY
✦ Sugars (added)
● Fat (naturally occurring and added)
These symbols show fats,oils, and added sugars in foods.
Milk, Yogurt, and Cheese Group
2 to 3 Servings
Meat, Poultry, Fish, Dry Beans, Eggs, and Nut Group
2 to 3 Servings
Vegetable Group
3 to 5 Servings
Fruit Group
2 to 4 Servings
Bread, Cereal, Rice, and Pasta Group
6 to 11 Servings

Figure SP 4.5.4A Food Guide Pyramid

DASH

Name____________________

Date____________________

STUDENT PAGE 4.5.4B FOOD GROUPS

1. Organize the following foods into the three groups of the Activation, Regulation, and Fabrication (ARF) system.

bread
beans
cornflakes
pineapple
eggs
butter
steak
cheese
apples
potatoes
carrots
nuts
milk
margarine
fish
chicken
spinach
rice

ACTIVATION	REGULATION	FABRICATION

Name ____________________

2. Organize the following foods into the six groups of the Food Guide Pyramid system.

bread
beans
cornflakes
pineapple
eggs
butter
steak
cheese
apples
potatoes
carrots
nuts
milk
margarine
fish
chicken
spinach
rice

CEREAL AND BREAD	DAIRY PRODUCT	FRUIT	VEGETABLE	MEATS	FATS AND SWEETS

Name ______________________

3. List 1–4 foods in each group of the Food Guide Pyramid system that contain fat.

CEREAL AND BREAD	DAIRY PRODUCT	FRUIT	VEGETABLE	MEATS	FATS AND SWEETS

4. List 1–4 foods in each group of the Food Guide Pyramid system that contain sugar.

CEREAL AND BREAD	DAIRY PRODUCT	FRUIT	VEGETABLE	MEAT	FATS AND SWEETS

Name ______________________

5. List the foods in their Pyramid groups and the number of servings you get of each food in your school lunch.

	CEREAL AND BREAD	DAIRY PRODUCT	FRUIT	VEGETABLE	MEAT	FATS AND SWEETS
Total servings						
Recommended servings	6–11	2–3	2–4	3–5	2–3	Sparingly

ACTIVITY 4.5.5 DIGESTION GAME

OBJECTIVES

The students
- Play a digestion simulation game.
- Classify foods using the Food Pyramid system.
- Locate where foods in each of the groups of the Pyramid system are digested and absorbed in the digestive tract.
- Relate the game foods to their principal function—activation, regulation, or fabrication.
- Analyze the game for its relationship to actual digestion.

BACKGROUND

This is the last of the nutrient-digestion sequence of activities. It is preceded by Activity 4.5.4 FOOD GROUPS in which the students categorize foods according to the Food Guide Pyramid and Activation, Regulation, and Fabrication (ARF) systems.

The Game

This activity is presented in a game format. It is designed to further compare the ARF system of food classification based on bodily function with the Food Pyramid system. In preparation for the game, the students write the nutrient functions and the food groups of the Pyramid system on tokens representing servings of specific foods. They then take turns moving the tokens through the "digestive tract" on a game board. Servings of food are first "digested" into nutrients. The nutrients are then absorbed, circulated, and eventually used in carrying out bodily functions. Digestion is shown by turning over the token so that its **Nutrient Function** side faces upward. The game is driven by rolling a die or a pencil-roller.

Winning

The game is played as a contest between two to four players to see which player can get the most foods digested and used to carry out bodily functions. Players must be alert so their tokens are not eliminated as waste. If they choose, they need not take a move until they get a desired number on the die or roller. This way they can ensure that their tokens are digested and absorbed.

Pencil-Roller
A pencil-roller can be made by wrapping a piece of tape around one end of a hexagonally cut pencil and marking the sides 1–6.

MATERIALS

1 pencil-roller or die
Scissors
Transparent tape
Overhead projector and overhead transparency of the game board
Student Page 4.5.5A DIGESTION GAME
4.5.5B QUESTIONS ABOUT THE DIGESTION GAME

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Have the students prepare for the game. Have them use Student Page 4.5.5A DIGESTION GAME.**

   Have them
   - Make a six-sided pencil-roller if a single die is not available.
   - Cut out the tokens and fold them in half, securing them with a small piece of transparent tape.
   - Write on the token the name of food group of the Food Pyramid system that the food on the token represents.
   - Write on the token the principal function of the food serving shown on the token—Activation, Regulation, or Fabrication.

2. **Introduce the game and rules. Use an overhead projector and transparency of the game board to show how two persons can play the game.**

   - Players: 1–4 persons.
   - Players determine their own method of deciding who plays first.
   - The winner of the game is the player who gets the most food servings digested, absorbed, and used.
   - To start the game players draw one token each from a "hat."

- The game is driven by the rolling of a die or a pencil-roller to determine the number of spaces that a token moves. Players may decline to move the token the number of spaces rolled at any time. They simply do not move the token and pass the roller or die to the next player.
- Foods that leave the system as waste are **out** of the game.
- When tokens are used or turned to waste, the players draw another token and start anew until all tokens have been used.

THE MOUTH

- Tokens first enter the mouth at the START CHEW space.
- From the START CHEW space, the tokens move the number of spaces shown on the roller or die.
- Whenever a token lands on a space where its group is digested, it is turned over to show its Nutrient Function. For example, If the token represents the Bread and Cereal Group and it lands on CEREAL DIGESTED, it would be turned to show its principal Nutrient Function, Activation.
- Once digested, a token remains digested and is not turned back over.
- Food remains in the mouth being chewed and possibly digested until the player gets the exact number of spaces required to land on a SWALLOW space. When this happens, the token can move toward the stomach on the next roll.

THE STOMACH

- Food remains in the stomach being mixed with digestive juices until the token rests on the VALVE OPENING space. When this happens, the food or nutrient can pass into the intestine on the next roll.
- Meat and milk products are digested in the stomach. If a Milk or Meat Group token lands on the MEAT/MILK DIGESTION space, digestion should be indicated by turning the token over to show its Nutrient Function, Fabrication.

THE SMALL INTESTINE

- Whenever a token with its **Nutrient Function** side showing lands on an ABSORPTION SPACE, it enters the circulatory system on its next move. Undigested foods not absorbed into the blood are removed as **waste.**

- At the end of the small intestine, foods that have not been digested and nutrients that have not been absorbed may go back through the system if the token lands on the GO BACK TO BEGIN INTESTINAL DIGESTION space. Tokens are placed on the first space of the small intestine and are given another chance to be digested or absorbed. This corresponds to the back-and-forth movement of the intestine's contents during digestion.

THE CIRCULATORY SYSTEM

- Once in the circulatory system, tokens move to the site where they carry out their function.

THE LARGE INTESTINE

- In the large intestine, digested and undigested foods are dehydrated and leave the system as **waste.**

3. **Have the students play the game several times to explore the process of digestion.**

4. **Summarize the activity. Have the students complete Student Page 4.5.5B QUESTIONS ABOUT THE DIGESTION GAME.**

Ask such questions as

- What are the special nutrients in bread and cereals? (Refer to Activity 4.5.1 NUTRITION MESSAGES, noting that the special nutrients are carbohydrates.)
- Where are carbohydrate materials digested? (From the game note that they are digested in the mouth and in the small intestine.)
- What are the special nutrients of the Meat and Milk Groups? (Refer to Activity 4.5.1, noting that the nutrients are proteins.)
- Where are proteins digested? (From the game, note that they are digested in the stomach and in the small intestine.)
- What are the special nutrients of the Fruit and Vegetable Groups? (Refer to Activity 4.5.1, noting that they are the minerals and vitamins.)
- Where are minerals and vitamins processed? (From the game, note that they are processed in the small intestine.)
- Where is most of the water removed the digestive tract? (Work toward agreement that most of the water is removed in the large intestine.)
- How are carbohydrates used in the body? (Work toward agreement that they are an energy source.)

- How are proteins used in the body? (Work toward agreement that they are used as body-building materials.)
- How are fats used in the body? (Work toward agreement that they are used as an energy source and as body-building materials.)
- How are minerals used in the body? (Work toward agreement that they are body regulators and body-building materials.)
- How are vitamins used in the body? (Work toward agreement that they are body regulators.)
- What are the wastes from the digestive system? (Work toward agreement that they are feces.)

EXTENSIONS

- Have students invent a life-sized simulation showing how different foods pass through the digestive tract and are digested.

DASH

SP 4.5.5A DIGESTION GAME

Name ______________________
Date ______________________

Nutrient Function
Food Group

CHEESE

Nutrient Function
Food Group

BEEF

Nutrient Function
Food Group

FISH

Nutrient Function
Food Group

BEAN

Nutrient Function
Food Group

MILK

Nutrient Function
Food Group

YOGURT

Nutrient Function
Food Group

BREAD

Nutrient Function
Food Group

RICE

Nutrient Function
Food Group

DOUGHNUT

Nutrient Function
Food Group

POTATO

Nutrient Function
Food Group

CHICKEN

Nutrient Function
Food Group

CARROT

Nutrient Function
Food Group

PINEAPPLE

Nutrient Function
Food Group

MANGO

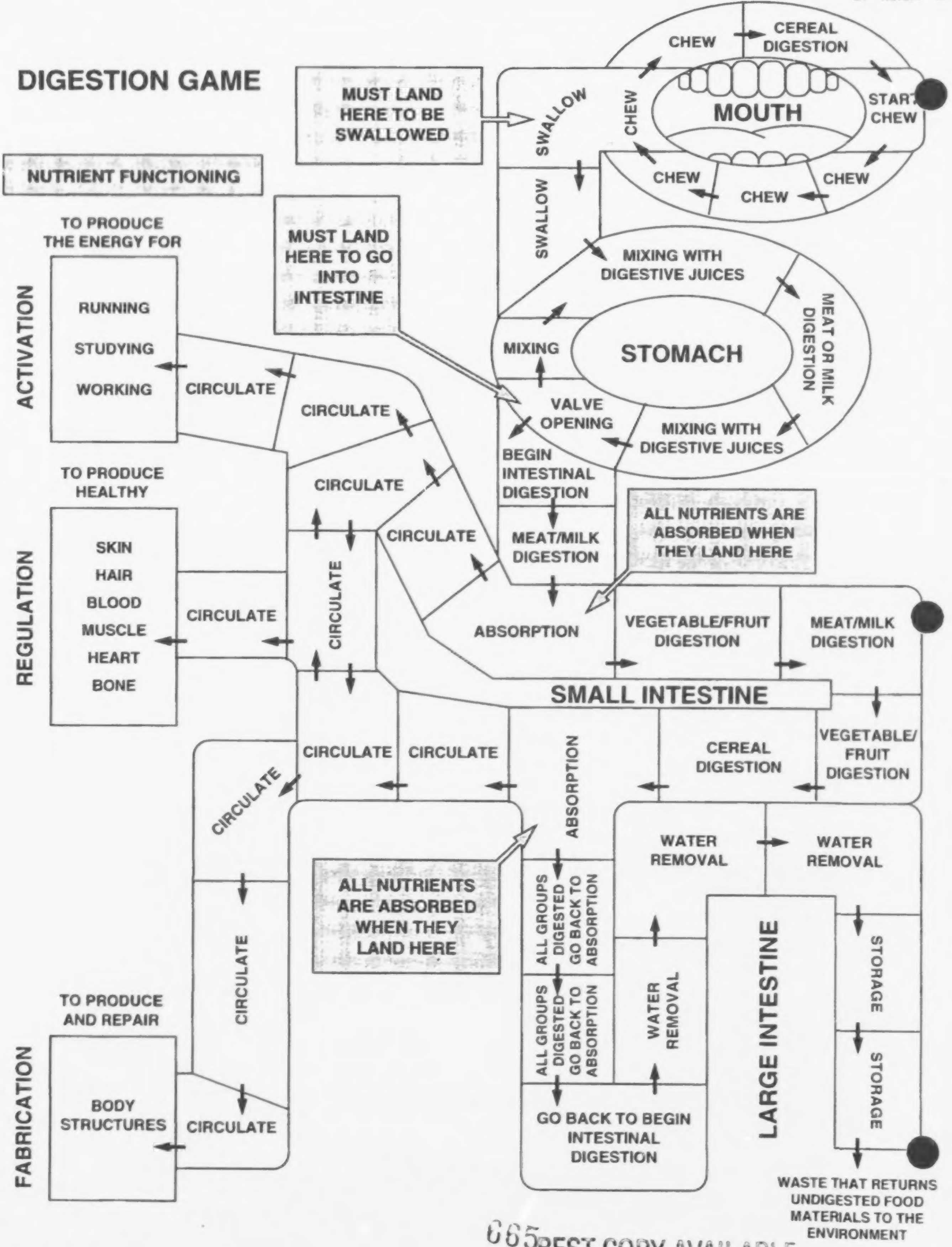
Nutrient Function
Food Group

SPINACH

FOOD TOKENS

BEST COPY AVAILABLE

DIGESTION GAME


NUTRIENT FUNCTIONING
MUST LAND HERE TO BE SWALLOWED
MUST LAND HERE TO GO INTO INTESTINE
MOUTH
START
CHEW
CEREAL DIGESTION
CHEW
CHEW
CHEW
CHEW
CHEW
SWALLOW
SWALLOW
STOMACH
MIXING WITH DIGESTIVE JUICES
MEAT OR MILK DIGESTION
MIXING WITH DIGESTIVE JUICES
VALVE OPENING
MIXING
BEGIN INTESTINAL DIGESTION
MEAT/MILK DIGESTION
ALL NUTRIENTS ARE ABSORBED WHEN THEY LAND HERE
ABSORPTION
VEGETABLE/FRUIT DIGESTION
MEAT/MILK DIGESTION
SMALL INTESTINE
VEGETABLE/FRUIT DIGESTION
CEREAL DIGESTION
ABSORPTION
ALL NUTRIENTS ARE ABSORBED WHEN THEY LAND HERE
ALL GROUPS DIGESTED GO BACK TO ABSORPTION
ALL GROUPS DIGESTED GO BACK TO ABSORPTION
GO BACK TO BEGIN INTESTINAL DIGESTION
WATER REMOVAL
WATER REMOVAL
WATER REMOVAL
LARGE INTESTINE
STORAGE
STORAGE
WASTE THAT RETURNS UNDIGESTED FOOD MATERIALS TO THE ENVIRONMENT
ACTIVATION
TO PRODUCE THE ENERGY FOR
RUNNING
STUDYING
WORKING
REGULATION
TO PRODUCE HEALTHY
SKIN
HAIR
BLOOD
MUSCLE
HEART
BONE
FABRICATION
TO PRODUCE AND REPAIR
BODY STRUCTURES
CIRCULATE
CIRCULATE
CIRCULATE
CIRCULATE
CIRCULATE
CIRCULATE
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CIRCULATE
CIRCULATE
CIRCULATE
CIRCULATE

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Name ______________________

Date ______________________

DASH

STUDENT PAGE 4.5.5B
QUESTIONS ABOUT THE DIGESTION GAME

1. What happens to food in the mouth?

____

____

____

2. Look at the game board. Where in the digestive system does the digestion of each of the following groups of food take place?

Bread and Cereal Group ______________________

Meat Group ______________________

Milk Group ______________________

Vegetable Group ______________________

Fruit Group ______________________

Fats, Oils, and Sweets Group ______________________

3. Each of the food groups is rich in what kind of nutrients?

Bread and Cereal Group ______________________

Meat Group ______________________

Milk Group ______________________

Vegetable Group ______________________

Fruit Group ______________________

Fats, Oils, and Sweets Group ______________________

Name ______________________

4. What do we call the process of breaking food up into nutrients? ______________________

5. What passes from the small intestine into the circulatory system?

____

____

____

6. What happens to nutrients once they are in the circulatory system?

____

____

____

7. How are the following nutrients used in our body?

Carbohydrates ______________________

Fats ______________________

Proteins ______________________

Minerals ______________________

Vitamins ______________________

Water ______________________

8. What is in the waste from our digestive tract?

____

____

ACTIVITY 4.5.6 PRESERVING FOODS

OBJECTIVES

The students
- Preserve food
- Test their preserved food by burying it.

BACKGROUND

This activity focuses on food preservation practices that have been used since ancient times. It can be used with Activity 4.3.16 CLEANING FISH: INTERNAL ANATOMY in which a fish is cleaned for eating. If this is done, see Drying and Salting Meat below.

Prior to the invention of canning in the first years of the 1800s, drying meat, fruit, vegetables, and grains was the most common method of preserving food for humans and animals. In addition, ice cut from rivers and ponds in the winter and kept in well-insulated buildings (ice houses) was used in northern latitudes for storing meat. Ice was even shipped into the tropics. Salt-and-vinegar pickling was used with vegetables, salting and smoking were used with meats, and cool cellars were used for preserving fruits and vegetables.

In this activity the students use one or more of these ancient techniques or the more modern technique of canning to preserve food. They then bury some part of their preserved food in a plastic bag or jar along with a sample of unpreserved food in a similar container to see how they fare over time.

If fish are to be preserved, the activity can be done with the fish cleaning. Otherwise you probably will wish to carry this activity out in the spring of the year when fruit and vegetables are readily available. The students may wish to work with the third graders who are growing a garden.

Drying Fruit

Probably the easiest technique to use in preserving fruit and seeds is drying. A motivator here can be making a tasty snack food.
- Place the fruit to be dried on wax paper in a shallow box lid 2.5–5.0 cm (1–2 in) deep.
- Spread individual pieces evenly over the paper so that they do not touch each other.

- Cover the box with cheesecloth and place it in the sun. The cheesecloth prevents insects, especially flies, from getting at materials being dried while allowing moisture to escape into the air.
- Regularly turn the food to expose all sides to air.
- At the first hint of rain bring the box indoors. Moisture can cause the fruit to mold.
- Continue drying until the food is dry and stiff.
- Store in sealed containers.

Drying and Salting Meat

- Thin strips of beef or thin fillets of fish can be covered with salt and dried in the same way as fruit. Salt is both a preservative and a dehydrating agent.
- Meat should be quite stiff when fully dried.
- Store in sealed containers.

Smoking Meat

You will need to contact someone who has a portable smoking outfit. This technique may be difficult to use at school.

Pickling Vegetables and Meats

This technique is used for many vegetables and some meats. It will require a heat source and sealable jars. Good recipes can be found in cookbooks and DASH 3 materials.

Canning

There are two distinct kinds of canning:

- Open canning of acid foods (fruits and tomatoes).
- Pressure cooker canning for non-acid foods (vegetables and meats). Open canning can be done with boiling water. Pressure cooker canning needs special equipment. For instructions, see a comprehensive cookbook.

STUDENT ROLES

Food processor
Householder

MATERIALS

Variable according to method chosen
Student Page 4.5.6 PRESERVING FOOD

PRODUCTS

Preserved food
Completed Student Pages

PROCEDURES

1. **Explain that we need to see how food can be preserved. Assign students to find how to preserve food by canning, pickling, smoking, drying, and so forth.**

2. **Have the students decide on a method or group of methods to be used in preserving food and what foods are to be preserved.**

    - Go over the steps with the students.
    - Assign students to assemble equipment as needed.
    - Have the students carry out the preservation techniques chosen.

3. **Summarize the preservation.**

    Ask such questions as
    - What did the food look like before we started?
    - How did it look after we completed the preserving process?

EXTENSION

- Invite parents to come in and work with the students on canning foods.

Name____________________________

Date____________________________

DASH

STUDENT PAGE 4.5.6 PRESERVING FOOD

1. Describe how you preserved food.

2. Describe what you did in burying the preserved food and predict how it will look when it is dug up. Also predict what the unpreserved food will look like.

Name________________________

Date________________________

STUDENT PAGE 4.5.1 NUTRITION SECRET MESSAGES

1. Decode the messages that follow using the Nutrition Secret Message Code and Decoder Sheets. When the messages have been decoded, continue with Item 2.

2. Give your working definition for the term "nutrient."

3. Give your working definition for the term "organ."

4. Give your working definition for the term "tissue."

5. Give your working definition for the term "cell."

Name ________________________

6. What is meant by a food "rich in carbohydrates"?

____

____

7. List four foods rich in carbohydrates.

____

____

8. List four foods rich in proteins.

____

____

9. List four foods rich in fats.

____

____

10. List four foods rich in minerals.

____

____

11. List four foods rich in vitamins.

____

____

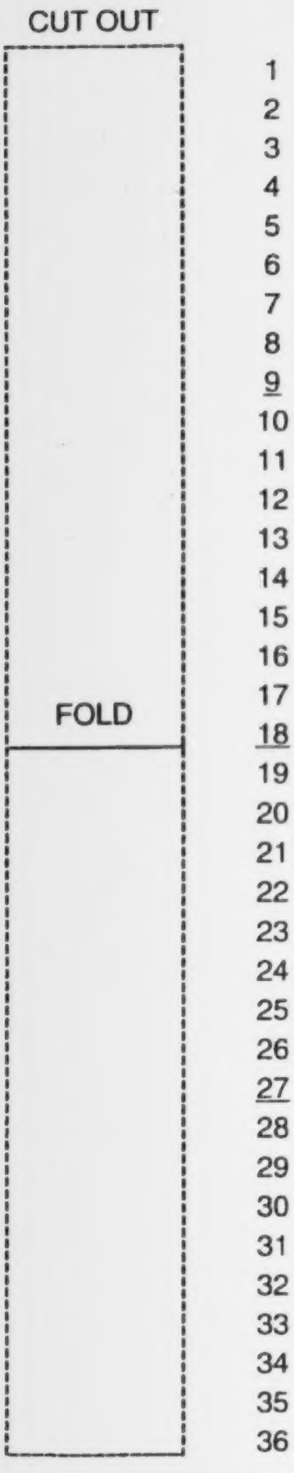
12. List four foods rich in water.

____

____

Name ______________________

NUTRITION SECRET MESSAGE CODE SHEET


CUT OUT
FOLD
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
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26
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32
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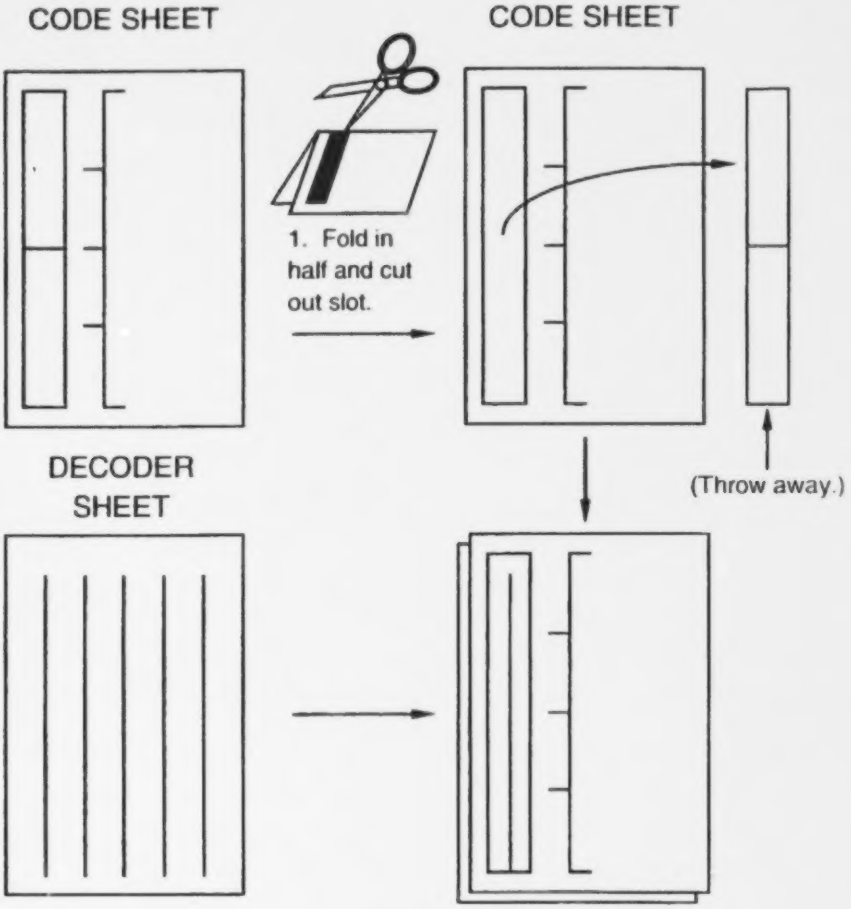
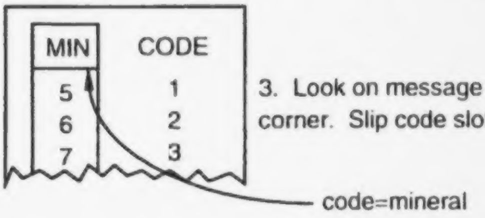
35
36

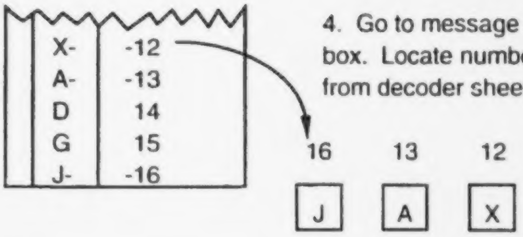

CODE SHEET
CODE SHEET
DECODER SHEET
(Throw away.)

1. Fold in half and cut out slot.

2. Place code sheet over decoder sheet.


MIN
CODE
5
1
6
2
7
3
code=mineral

3. Look on message sheet for code name in upper left corner. Slip code slot over the code name column.


X-
-12
A-
-13
D
14
G
15
J-
-16
16
13
12
J
A
X

4. Go to message sheet; find code number above box. Locate number on code sheet. Read letter from decoder sheet.

SP 4.5.1—4

Name ____________________

NUTRITION SECRET MESSAGE DECODER SHEET

CARB	FAT	PRO	MIN	VIT	WAT	TIS	OPT
1	9	7	5	4	8	2	3
9	7	5	6	3	9	8	0
6	5	2	7	6	5	9	1
5	3	3	1	8	6	3	4
4	1	4	0	9	1	5	7
3	2	1	3	5	0	1	2
2	4	8	4	0	2	4	6
7	6	9	8	7	7	0	9
0	8	6	9	2	3	7	5
8	0	0	2	1	4	6	8
W	C	F	L	A	K	C	E
Z	F	I	X	D	L	O	Q
K	I	L	A	G	J	G	T
H	L	X	D	E	B	E	J
E	0	A	G	H	S	Q	L
B	R	D	J	U	P	T	W
P	U	G	B	K	Y	M	H
M	X	J	E	Z	A	I	Z
J	A	M	H	M	D	P	B
G	D	P	U	I	N	A	S
U	G	S	V	N	Q	X	Y
R	J	B	Y	Q	T	J	C
0	M	E	K	T	M	L	K
L	P	H	W	C	I	D	M
C	S	K	Z	0	H	N	I
F	V	W	M	R	U	R	P
I	Y	Z	P	F	V	F	A
N	B	C	S	S	Z	K	0
Q	E	0	F	P	G	W	G
T	H	R	I	Y	E	H	D
Y	K	U	N	V	C	U	N
V	N	V	Q	W	0	V	R
S	Q	Y	T	L	R	Z	F
D	T	N	C	X	F	B	X
A	W	Q	0	J	X	S	U
X	Z	T	R	B	W	Y	V

The DASH Project, University of Hawaii, CRDG

10.11.94

SP 4.5.1—5

Name ______________________

NUTRITION SECRET MESSAGES

Code
TIS
Page 1

TISSUES, CELLS, NUTRIENTS

12 24 18 35 17 20 14 31 19 19 26 16
1. Our B○○○E○ are ○○D○ ○○of○A○○S that we
12 26 20 25 30 14 26 16
call ○○G○○S. Examples of organs include our ○○A○○,
23 31 13 35 35 16 12 20 11 14 14
○○N○○, ○○○M○○H, intestines, ○Y○S, and legs.
19 23 36
Each organ ○○A○S a special role in our body. Our
30 14 26 19 17 19 23 25 13
○○A○T ○U○○S blood, our ○U○○S exchange
11 20 34 12 24 18 21 24
○○R○○N ○○O○I○E for oxygen.

17 20 14 16 18 31 14 35
2. Organs are ○○D○ of parts called ○○SS○○○ that are
20 24 14 11 23 23 35 14 23 23
M○○○ of other parts called ○E○○○ cells. C○○○S
31 25 18 16 35 23 18 32 13 16 30 18 25 13
are the ○○○○○ out of which ○○○IN○ ○○○○○S
35 25
are built. The cells in tissues can be ○EE○ only under a
17 18 11 12 11 12
○○○R○S○○PE.

17 31 35 23 14 35 30 20 18 26
3. Examples of tissues include ○○○C○○○, skin, ○○○○,
34 12 14 23 12 12
○○N○, nerves, and B○○○D.

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TIS
Page 2

34 23 12 24 11 26 26 35 21 36 13 25
4. ○○○o○ is a tissue that ○A○○IE○ o○○○E○ and
31 16 26 18 14 16 35
N○○○○○N○○ to other tissues in our bodies. It carries
11 20 26 12 25 18 12 21 18 14 29 20 16 14
○○○B○○ D○○○○D○ and other ○○S○○ away from
23 31 13 35 13 18 14 35 31 19
tissues. In our ○○N○○, the blood ○○V○○ ○○ the
20 18 26
carbon dioxide to the ○○○. Other waste goes to the
28 18 24 25 36 35 14 17 12 32 23
○○○○E○○ for R○○○○A○ through the
19 26 12 14 35 31 26 18 20 16 18 12
○○○C○○S of ○○○N○○○○N.

27 12 24 35 23 18 18 25 13 16 30 18 13 35
5. ○○o○○ come from ○○V○○○ ○○○N○○ that are
17 20 24 14 16 35 31 14 34 31 18 23
also ○○○○ of ○I○S○○ and cells. Cells are ○○○○T
11 30 14 18 11 20 19 20 26 25 31 16 26 25 16 35
from ○○○M○○○L ○○○TS called ○○○○IE○○○.
24 18 13 35 16 18 12 19 26 12 11 14
In the ○○○E○○○○N ○○○○○SS cells are
34 26 12 28 14 25 24 12 29 25 16 26 14 25 16
○○○○○○ ○○○N into ○U○○I○○○S. Our
12 24 18 14 34 31 18 23
B○○○○S are ○○○○T out of these nutrients.

35 18 21 19 26 16 18 25
6. ○○○ types of nutrients exist. They are ○○o○E○○S, fats,
11 20 34 12 30 24 26 20 14 35 29 20 16 14
○○R○○○Y○○○T○○, minerals, vitamins, and ○○○○R.

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TIS
Page 3

34 12 18 14
7.Nutrients have three basic functions in our ○○D○○S.
27 18 35 16 27 31 14 23 20 11 16 32 20 14
○○R○○, they are used as ○○○○ to ○○○I○○T○our
34 25 18 35
○O○○E○.

35 14 11 12 25 24 11 30 17 18 11 23
8.○○○○○○, they provide ○○E○○○A○S to regulate our
13 26 12 18 13
bodily processes of ○○○W○N○, thinking, reproducing,
17 12 18 13 35 14 14 18 25 13
○○V○N○, breathing, ○○○○○○, and many more.

16 30 26 27 34 26 11 16
9.○○I○D, nutrients are used to ○A○○I○A○E or
34 18 23
○U○○D our bodies.

26 18 11 30 24 18 27 14 14 25
10.Different foods are especially ○○○○ in ○○F○○R○○T
19 12 20 12 14 26 18 11 14
nutrients. For example, ○○T○T○○S and ○○○○ are
11 20 26 12 30 24 26 20 16 35 34 31 16 26
especially rich in ○○○B○○Y○○○○E○. ○○T○E○
17 26 13 26 25 14 27 20 16 17 14 16
and ○A○○A○I○○are especially rich in ○○○, ○○A○
19 12 16 18 25 32 14 14 16 34 23 14 35
is rich in ○R○○E○○S, and fruits and○○G○○A○○○○
17 18 14 26 23 35 32 18 20 17 18 26
are rich in ○○N○○A○○ and ○○T○○○○S.

Name ____________________

Code
CARB
Page 1

CARBOHYDRATES

1. 25 22 16 23 14 31 34 35 30 33 28 21 22 27 15 28 33
○A○○○○○○R○○E○ are ○○T○○○○T○.

2. 25 15 18 35 24
Examples of carbohydrates are ○H○○IC○○S called
33 20 22 33 30 25 14 15
○U○A○S and ○○AR○○○S.

3. 21 33 15 34 16 23 27 15 33
Carbohydrates are mostly ○○○○ in our ○○D○○○ for
15 15 22 20 31 17 24 35 28 30 33
○N○○○○ and in ○○○○○○for
21 27 24 27 28
B○○○D○○G materials.

4. 17 23 21 28 7 17 28 34 33
A 100-○○○○D person has about ○ ○OU○○○ of
18 35 33 33
carbohydrates in body ○○○○.

5. 27 20 33 30 15 34 18 21 14
Carbohydrates are D○○E○○○○ in the ○O○T○ and in
27 28 15 30 27 28 15
the ○○T○S○○○○.

6. 33 30 35 25 14 15 16 23 13 15
During digestion ○○○R○○○S are ○R○○○N
21 17 33 21 35 22
○○into ○○G○○S.

7. 35 22 22 27 15 34 16 24 34
Carbohydrates are C○○○○○○ in the ○○OO○ as
21 20 35 22 33
S○○○○○.

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Code
CARB
Page 2

25 15 24 24 33 16 21 22 33 21 22 33
8. ○○○○○ ○○○N ○○GA○○ to produce
15 28 20 31 33 21 20 25 35 28 15 34
○○ER○○ and extra ○○○AR is ○H○○G○○ into
26 35 30
○○○.

16 21 28 11 35 22 25 35 23 28
9. When sugars ○○R○, ○○TE○, ○○RB○○
23 36 27 34 15 15 28 20 31
DI○○○○○, and ○○ER○○energy are produced.

23 23 34 16 15 35 33
10. F○○○S rich in carbohydrates are ○R○○D○,
25 15 35 22 27 25 15 28 23 24 15 33
○ER○○LS, ○○○○, ○O○D○○○,
17 23 35 30 23 15 25 35 34 31
○○T○○○○S, and ○○N○○.

25 35 22 16 23 31 22 35 30 18 23 33 30
11. ○○○○○H○D○○○ES make up ○○○○of the
18 33 33 26 21 27 30 33
non-water ○A○○ of ○R○○○○ and
32 15 30 35 16 24
○○GE○○○○ES.

22 15 25 18 34 15 34
12. It is ○○○OM○EN○○○ that between 55% and 60% of our
26 23 34 28 21 22 27 15 28
○○O○ ○○T○○○○TS should be carbohydrates.

Name ______________________

Code
PRO
Page 1

PROTEINS

20 29 23 12 34 34 31 30 23 36 21
1. ○R○T○○○S are ○○T○I○N○○.

30 36 34 21 31 21 16 22 16 23
2. P○O○EI○○ are ○○E○ in our ○O○I○S for
23 23 17 33 22 13 16 34 17
○N○R○○, as ○UI○○I○○ materials, and as
30 23 13 36 16 29 30
○○GU○A○○RS of the way our bodies W○○K.

6 10 10 31 34 16 3 3 20 29 16
3. A ○○○-PO○○○ person has about ○○ ○○UN○S of
19 15 21 21
protein in body ○○○○.

16 17 21 36 16 21 19 15 28
4. Proteins are ○I○E○○E○ in the ○TO○○○H and
12 36 21 36 34 23 21
○N○E○○I○○○.

16 17 23 21 12 22 29 23 34 31 20
5. In ○I○○○T○ON, proteins are ○R○K○○ ○○ into
24 23 12 15 13 21 19 34 29 15 12 16
C○○M○C○○○ called A○I○○ ○C○○S.

15 12 29 28 12 21 23 13 21
6. ○M○N○ A○○D○ are carried to our C○○L○ by our
22 29 16
○L○O○.

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PRO
Page 2

28 13 21 20 29 36 12 34 23 26
7. Our ○E○L○ rebuild ○R○○E○NS to make ○○○
28 13 13 21 19 15 36 15 12
○E○○○ and ○○IN○○○N old ones.
24 30 29 34 21 12 17 36 12 32 23
They also make ○O○M○○E○, D○○ES○○○○
18 12 23 21 28 23 19 12 15 21
○U○C○○, and other ○H○○○C○L○ that
30 23 13 36
○○GU○A○E our bodies.

28 23 21 21 15 12 34 15 12 16
8 EX○○○○ ○M○○O ○C○○S can be changed
11 15 21 23 23 21 15 19 34 29 28 12
into○○T○. ○XC○○S ○○I○○ A○○D is
30 19 29 23 31 12 34 23
usually ○E○○V○D from our bodies as ○R○○○.

29 29 16 30 28 19 15 36 21 17 21
9. F○○○S ○I○H in proteins are ○E○○○, E○G○,
22 15 21 34 36 21
○E○N○, and ○U○○.

22 29 31 3 10 11 29 16 31 36 12 23 34 36
10. A○○○T ○○% of our ○○O○ N○○R○○○○ should
20 36 23 12
be ○RO○○○N.

Name ______________________

Code
FAT
Page 1

FATS

12 34 25 32 17 34 16 29 32
1. ○A○○ are ○○○○I○○TS.

19 34 15 20 13 29 12 29 14
2. F○○S are used in our B○○○○S as ○U○○, as
28 17 20 13 32 21 25 15 16 29
○○IL○○○○ materials, and as a ○T○○○ of
32 29 21 27
E○○R○○.

5 10 10 24 15 17 32 20 5 6
3. A ○○○ ○○○○○ person has about ○○
15 17 32 20 23 19 25 25
P○○○○S of fat in body ○○○○.

20 13 21 25 29 20 13 32 34 34 13 32 29
4. Fats are ○○○E○T○○ in the ○○○ES○○○○S.

13 21 29 25 15 32 16 15 31 29 17 24
5. In D○○○○TI○○, some fat is B○○○○N ○○into two
12 34 34 11 20 21 29 16 13 32
chemicals called ○A○○Y A○I○S and ○LYC○○○○E.

19 34 27 19 11 20 25 14 11 29 13 29
6. F○○T○ ○○I○○ and G○Y○○R○N○ are carries to
11 29 14 25 28 14 15 15
our ○○L○○ by our ○○○○D.

12 19 34 11 14 14 34 15 16
7. Cells called ○○○ ○E○○S rebuild fat to S○○○E it.

Name ______________________

Code
FAT
Page 2

11 14 25 30 29 29 34 19 34 13 25 25

8. Fat ○EL○○ form great S○○○○S of F○○ T○○○UE

24 15 34 29 11 16 21 19 32 25

that surround and ○R○○○○T O○○○○○ such as the

30 29 16 34 14 17 21

○○A○○, ○○N○S and intestines.

17 21 16 24 16 34 29 13

9. Extra S○○A○ and ○○O○○○N can be changes into

28 15 27 19 34

○○D○ F○○.

28 17 16 29 35 34 29 11 16 28 15

10. Fat is also ○○○N○D to produce ○A○○R, ○A○○○N

20 13 18 13 20 29 32 16 21

○○O○○○E, and ○○E○○Y.

12 15 20 25 16 13 30 11 15 15 13 32 15 13

11. ○O○○○ ○○C○ in fats are ○○○K○○G ○○LS,

17 34 29 16 23 16 19 16 13 32 29 29 19

B○○T○○, ○A○G○○○○○, nuts, and M○○T.

11 23 23 29 32 20 4 10

12. It is RE○O○○○○DE○ that no more than ○○% of our

12 15 17 34 13 29 32 25

○○OD N○○R○○○T○ should come from fat.

Name ______________________

Code
MIN
Page 1

MINERALS

26 31 18 13 11 31 33 36 18 33 28
1. ○I○○R○○S are ○U○○I○N○○.

30 18 36 11 28 20 28 14
2. M○N○○A○○ are ○○E○ in our bodies as
17 30 11 14 31 15 26 23 30 15
○U○○○I○○ materials and in the ○A○○N○ of body
18 15 11 13 36 28
R○○U○○TO○○.

4 5 5 27 35 31 1 35 20 14
3. A ○○○-○○U○D person has about ○ P○○N○S
26 31 18 36 11 28
of ○I○○○A○○ in their body mass.

14 30 18 33 18 14 30 33 18 30 31 28
4. Minerals are ○○G○S○○○ in the ○N○○ST○○E○
18 11 11 17 35 35
and carried to C○○○S by the ○L○○D.

31 18 14 4 7 14 29 36 18 31 33
5. Our bodies ○○E○ at least ○○ ○IF○E○○○○
26 30 31 13 28
○○○ER○L○.

35 35 31 26 31 18 13 11
6. C○MM○○ ○I○○R○○S and some of their functions are
13 34 30 20 17 31 28 33 18 33
- C○L○○○M is used to build ○O○E○ and ○○E○H.
34 11 35 30 31 30 15 33 21 18
- ○H○○R○○E is used to make D○○ES○I○○
16 30 18 28
○U○C○○.

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MIN
Page 2

13 31 18 30 20 26 / 17 31 18
- M○G○○S○○○ is important in ○O○○ building and

14 30 18 28 33 35
○○G○○○I○N.

35 28 19 35 36 28 / 35 31 18
- PH○○P○○○U○ is used to build B○○○S and

33 18 19 / 18 18 15
○E○T○ and to help produce ○N○R○Yin cells.

35 13 28 28 20 26 / 18 36 21 28
- P○T○○○I○○ is important to our N○○○E○.

28 14 20 / 31 18 18
- ○O○I○M is important to our ○○RV○S.

36 31 / 35 12 22 15 31 / 11 35 14
- I○O○is used to carry ○○○○E○ in our B○O○○.

29 35 28 36 34 / 13 36
7. ○O○D○ ○I○H in minerals are D○I○Ydairy

27 14 34 33 / 29 20 30 33 28 / 21 18 18 17 11 18 28
○RO○U○○S, ○R○○○○, and○○G○TA○○○○.

Name ______________________

Code
VIT
Page 1

VITAMINS

31 23 20 21 28 16 23 20 14 23 28
1 ○I○AM○○○are N○○R○○N○○.

20 11 19 20 21 16 28 14 26 13 33 11 14
2. V○T○○○○S are ○○○D to ○E○U○○T○ the way
32 26 17
that our bodies ○O○○.

20 21 11 25 21 23
3. There are only T○○Y ○M○U○○S of vitamins in our
36 25 20 14
○○D○○S.

11 36 28 25 26 36 14 12 20 21 14 23 20 21
4. Vitamins are ○○○○○○○○in the ○○T○S○○○E.

15 11 23 15 14 12 9 7
5. For good ○E○L○○ our bodies N○E○at least ○○
12 20 27 14 23
○○F○ER○N○ vitamins.

25 19 25 31 20 23 20 21 28
6. C○M○○N ○○○AM○○○ and some of their
16 21 20 25 21
F○○CT○○○S are

11 16 21 13 28 28 20 21
- Vitamin ○ is necessary for healthy L○○○○, ○K○○,
31 28 25 21 12 13 23 20 21
○I○I○○, and ○I○ES○○O○.

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Code
VIT
Page 2

36 24 19 33 14 34 13 16 29
- Vitamin ○ ○O○P○○○ is a ○RO○○ of
31 20 19 20 21 28 33 25
○○TA○○○○ necessary for healthy B○O○D,
21 26 14 17 21 30 26 11 21 28
○E○V○S, and ○ID○E○S and other O○G○○○.

24 15 11 23 15 30 28 17 21
- Vitamin ○ is necessary for ○E○L○○○ ○○I○,
36 21 19 28 33 14
○O○E, and ○U○C○○.

12 36 25 14
- Vitamin ○ is necessary for healthy ○○N○S.

14 16 24 33 14
- Vitamin ○ is necessary for healthy M○S○○○S and for
26 26 25 16 24 20 25
○EP○○D○○T○○N.

17 36 33 25 25 24 25 23 20 21
- Vitamin ○is necessary for ○○○○D ○L○○T○○G
20 13 23 25
and for healthy D○○ES○I○N.

25 12 28 26 24 12 20 30
7. FO○○○ ○I○H in vitamins are ○A○R○
29 25 12 24 28 27 20 31 13 14 36 33 14
○R○○U○T○, ○RU○TS, and ○E○○TA○○○S.

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Name ____________________

Code
WAT
Page 1

WATER

36 22 33 26 22 30 20 22
1. ○A○E○ is a N○○RI○○○.

36 18 30 26 15 30 24 29 22 32 20
2. ○○T○R is ○○○D in our bodies in D○○ES○I○○, to
20 33 24 30 22 15 31 30 12 15
carry other ○UT○○○N○○ to ○○○L○, to carry
18 22 30 24 29
W○S○○ away, and to keep the R○○HT body
30 23 33 22 26 30
T○○PE○A○○R○.

5 6 6 32 26 19 4 6 16 26 20 19 15
3. A ○○○-P○○N○ person has about ○○ ○O○○○○
of
36 18 22 30 18 15 15
○○○○R in body M○○○.

36 30 33 32 22 32 32 19
4. ○AT○○ is N○○ a F○○○.

18 22 30 33 20 32 32 11 20 26 16 19 29 15 30 19
5. W○○○○ is ○○T BR○○E○ ○○ or ○I○E○T○○.
19 33 22 12 14 32 32
It goes ○I○EC○○Y into the ○L○○D from the
24 30 15 24 20
○NT○○T○○E.

18 22 30 33 18 27 30 15 15 30 18
6. W○○○○ LE○○○○ our bodies in ○W○○T, our
33 30 18 26 24 30 30 18 15 18 12 24 18
B○○○TH, ○R○N○, T○○R○, S○○○V○, and in
36 15 30 24 30 15 22 24 32
○A○T○ from D○G○○○○○○N.

Name ____________________

Code
WAT
Page 2

32 15 30 5 1 12 30 33 15 36 18 30 19 12 17
7. We L○○○ ○ to ○ ○IT○○○ of ○○T○R ○AI○○
36 30 33 33 30 18 30 19 24 12 17
and this ○AT○○ must be ○○PL○C○○ DA○○○.

32 26 33 31 30 15 36 18 22 34 26 20
8. S○○○○○○ of our ○○○ER are ○O○○D in
12 32 15 22 34 32 19 30 22
A○M○○○ all the ○○O○ we ○A○ and the
15 18 33 34 18 22 16 33 30 24 20 26 33
○UG○○, ○○○, and ○○OT○○○ we B○○N to
16 19 26 31 30 20 29 17
○RO○○○E ○○ER○○.

25 30 24 30 30 30 31 24 15
9. The ○○AV○○R we are , the more ○X○R○○○E
25 32 22 30 23 30
we do, and the ○○T○○R it is, the ○OR○
20 19
water we ○EE○.

19 34 34 24 26 12 23 31 25
10. It is ○I○○○C○○T to get too ○U○○much
36 22 30 33
○A○○○.

15 26 18 12 29 15 15 30 15 36 20 22 30
11. U○○○○LY 6 ○LA○○○○ in ○I○○○R
15 26 23 20 26 29 25
and 8 in ○○M○ER will be E○O○○○.

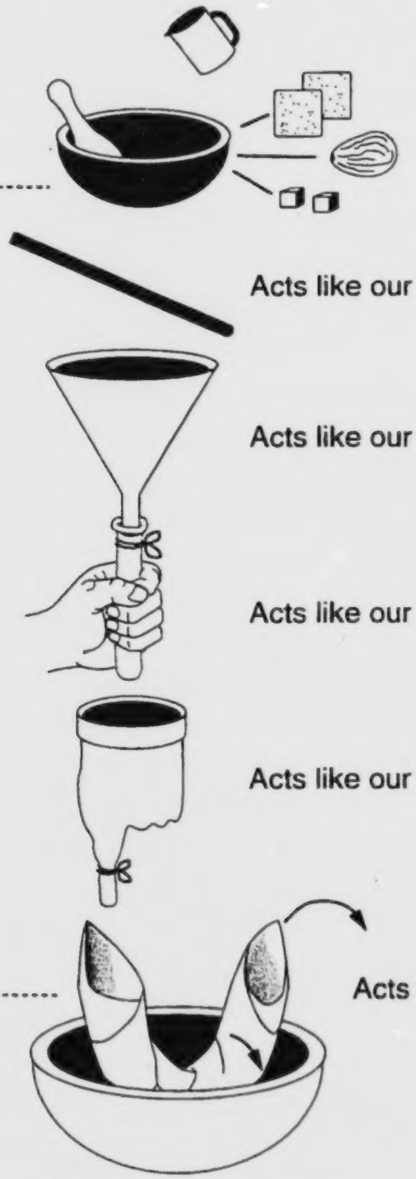
19 24 20 22 24 15 17
12. It is usually wise to ○R○○K when you are ○H○R○T○.

Name______________________________

Date______________________________

STUDENT PAGE 4.5.2 MECHANICAL DIGESTION SIMULATION

FILL IN THE BLANKS WITH THE NAMES OF THE ORGANS LISTED IN THE BOX



Acts like our ....

Acts like our ....

Acts like our ....

Acts like our ....

Acts like our ....

Acts like our ....

Acts like our ....

ORGANS

anus

esophagus

intestine

mouth

tongue

stomach

throat

Figure SP4.5.2 Setting up a mechanical digestion simulation

DASH

Name______________________

Date______________________

STUDENT PAGE 4.5.3 CHEMICAL DIGESTION

Record the name of each food beside its food type. Record any observations and the pH before and after the simulated digestion.

FOOD TYPE	FOOD TESTED	OBSERVATIONS	pH BEFORE	pH AFTER
Carbohydrate				
Fat				
Protein				

DASH

Name__________________________

Date__________________________

STUDENT PAGE 4.5.4A FOOD GUIDE PYRAMID

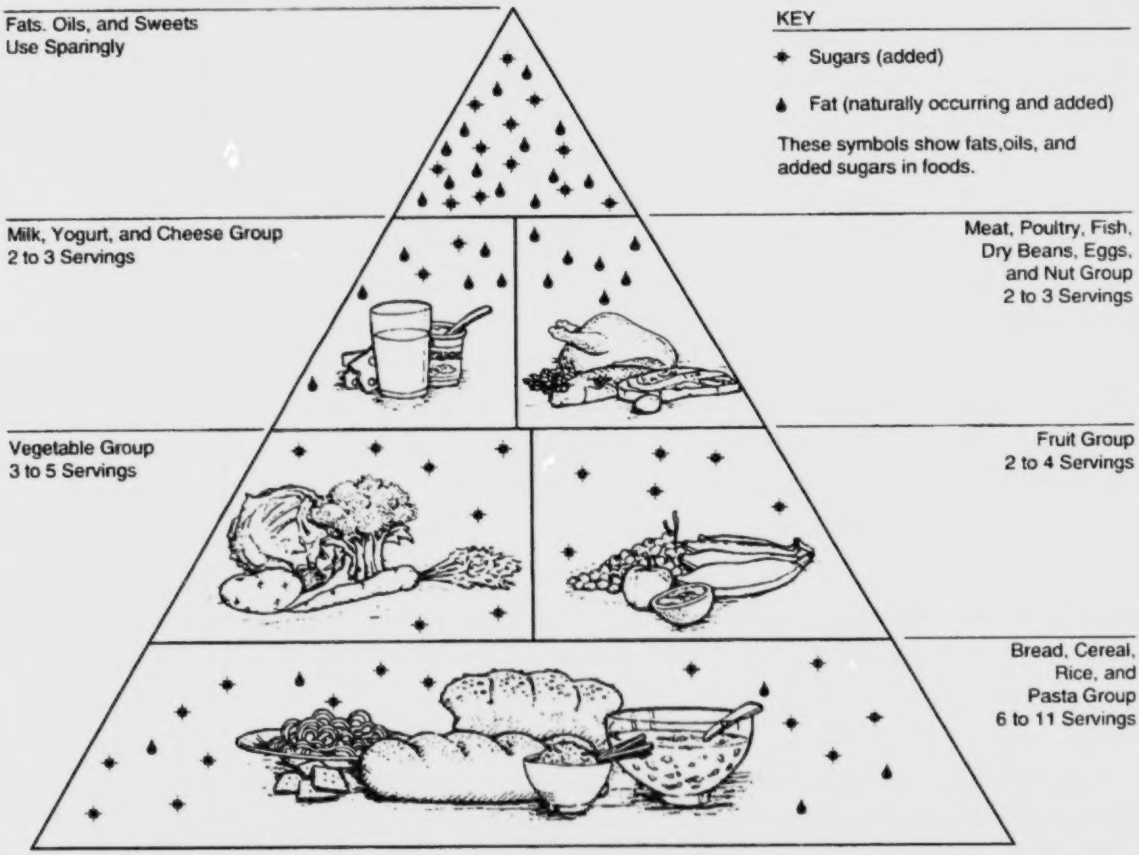

Fats. Oils, and Sweets
Use Sparingly
KEY
✦ Sugars (added)
● Fat (naturally occurring and added)
These symbols show fats,oils, and added sugars in foods.
Milk, Yogurt, and Cheese Group
2 to 3 Servings
Meat, Poultry, Fish, Dry Beans, Eggs, and Nut Group
2 to 3 Servings
Vegetable Group
3 to 5 Servings
Fruit Group
2 to 4 Servings
Bread, Cereal, Rice, and Pasta Group
6 to 11 Servings

Figure SP 4.5.4A Food Guide Pyramid

Name________________________

Date________________________

STUDENT PAGE 4.5.4B FOOD GROUPS

1. Organize the following foods into the three groups of the Activation, Regulation, and Fabrication (ARF) system.

bread
beans
cornflakes
pineapple
eggs
butter
steak
cheese
apples
potatoes
carrots
nuts
milk
margarine
fish
chicken
spinach
rice

ACTIVATION	REGULATION	FABRICATION

Name ____________________

2. Organize the following foods into the six groups of the Food Guide Pyramid system.

bread
beans
cornflakes
pineapple
eggs
butter
steak
cheese
apples
potatoes
carrots
nuts
milk
margarine
fish
chicken
spinach
rice

CEREAL AND BREAD	DAIRY PRODUCT	FRUIT	VEGETABLE	MEATS	FATS AND SWEETS

Name ____________________

3. List 1–4 foods in each group of the Food Guide Pyramid system that contain fat.

CEREAL AND BREAD	DAIRY PRODUCT	FRUIT	VEGETABLE	MEATS	FATS AND SWEETS

4. List 1–4 foods in each group of the Food Guide Pyramid system that contain sugar.

CEREAL AND BREAD	DAIRY PRODUCT	FRUIT	VEGETABLE	MEAT	FATS AND SWEETS

Name ____________________

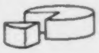
5. **List the foods in their Pyramid groups and the number of servings you get of each food in your school lunch.**

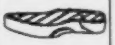
	CEREAL AND BREAD	DAIRY PRODUCT	FRUIT	VEGETABLE	MEAT	FATS AND SWEETS
Total servings						
Recom-mended servings	6–11	2–3	2–4	3–5	2–3	Sparingly

DASH

SP 4.5.5A DIGESTION GAME

Name ______________________________
Date ______________________________

Nutrient Function
Food Group

CHEESE

Nutrient Function
Food Group

BEEF

Nutrient Function
Food Group

FISH

Nutrient Function
Food Group

BEAN

Nutrient Function
Food Group

MILK

Nutrient Function
Food Group

YOGURT

Nutrient Function
Food Group

BREAD

Nutrient Function
Food Group

RICE

Nutrient Function
Food Group

DOUGHNUT

Nutrient Function
Food Group

POTATO

Nutrient Function
Food Group

CHICKEN

Nutrient Function
Food Group

CARROT

Nutrient Function
Food Group

PINEAPPLE

Nutrient Function
Food Group

MANGO

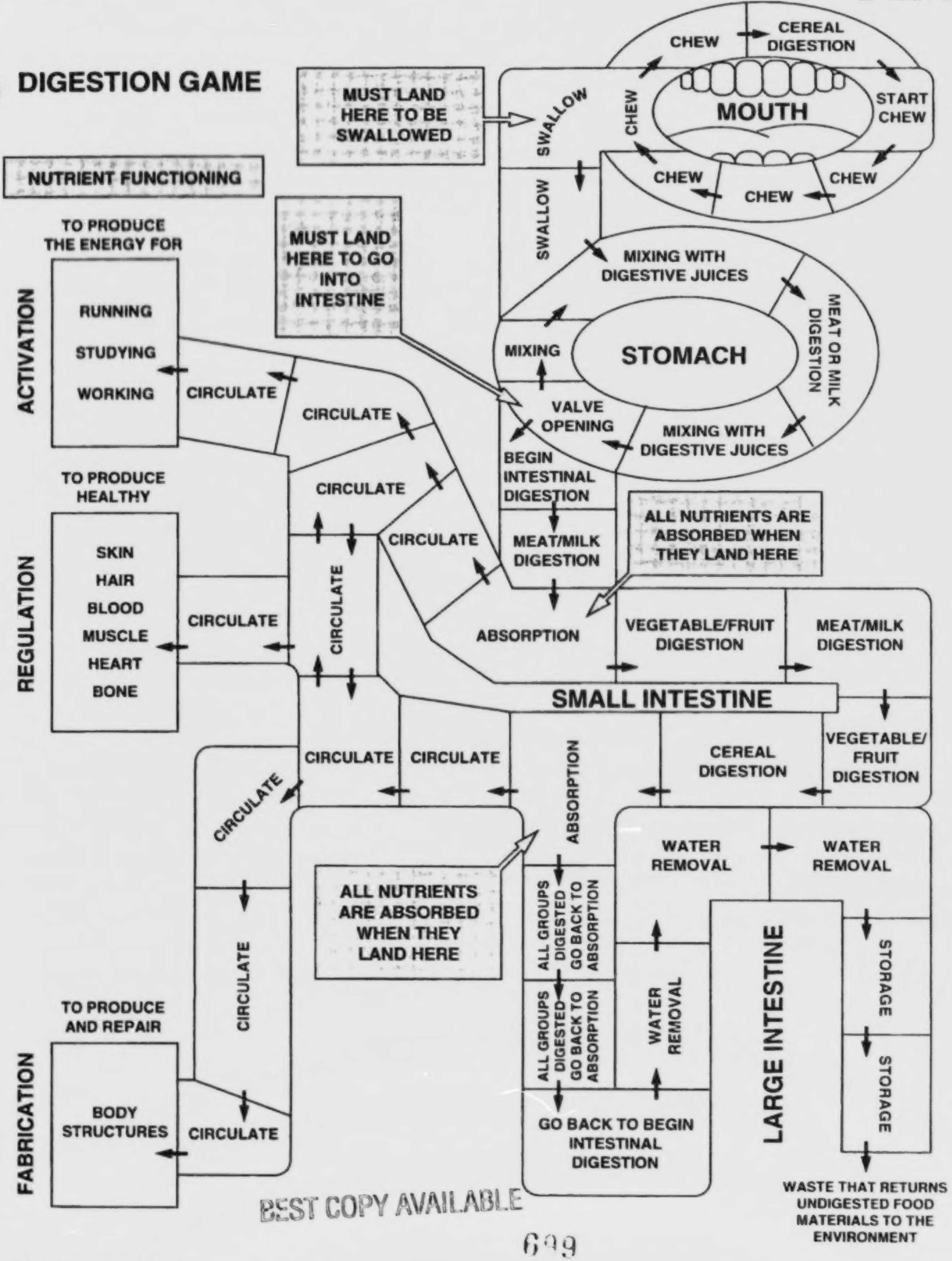
Nutrient Function
Food Group

SPINACH

FOOD TOKENS

BEST COPY AVAILABLE

DIGESTION GAME


MUST LAND HERE TO BE SWALLOWED
NUTRIENT FUNCTIONING
CHEW
CEREAL DIGESTION
START CHEW
MOUTH
CHEW
CHEW
CHEW
CHEW
SWALLOW
SWALLOW
MUST LAND HERE TO GO INTO INTESTINE
TO PRODUCE THE ENERGY FOR
ACTIVATION
RUNNING
STUDYING
WORKING
CIRCULATE
CIRCULATE
MIXING WITH DIGESTIVE JUICES
MEAT OR MILK DIGESTION
MIXING
STOMACH
VALVE OPENING
MIXING WITH DIGESTIVE JUICES
BEGIN INTESTINAL DIGESTION
TO PRODUCE HEALTHY
REGULATION
SKIN
HAIR
BLOOD
MUSCLE
HEART
BONE
CIRCULATE
CIRCULATE
CIRCULATE
CIRCULATE
MEAT/MILK DIGESTION
ALL NUTRIENTS ARE ABSORBED WHEN THEY LAND HERE
ABSORPTION
VEGETABLE/FRUIT DIGESTION
MEAT/MILK DIGESTION
SMALL INTESTINE
CIRCULATE
CIRCULATE
CIRCULATE
ABSORPTION
CEREAL DIGESTION
VEGETABLE/ FRUIT DIGESTION
ALL NUTRIENTS ARE ABSORBED WHEN THEY LAND HERE
WATER REMOVAL
WATER REMOVAL
CIRCULATE
ALL GROUPS DIGESTED GO BACK TO ABSORPTION
ALL GROUPS DIGESTED GO BACK TO ABSORPTION
WATER REMOVAL
LARGE INTESTINE
STORAGE
STORAGE
TO PRODUCE AND REPAIR
FABRICATION
BODY STRUCTURES
CIRCULATE
GO BACK TO BEGIN INTESTINAL DIGESTION
WASTE THAT RETURNS UNDIGESTED FOOD MATERIALS TO THE ENVIRONMENT

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DASH

Name ____________________

Date ____________________

STUDENT PAGE 4.5.5B
QUESTIONS ABOUT THE DIGESTION GAME

1. What happens to food in the mouth?

   ____

   ____

   ____

2. Look at the game board. Where in the digestive system does the digestion of each of the following groups of food take place?

   Bread and Cereal Group ____________________

   Meat Group ____________________

   Milk Group ____________________

   Vegetable Group ____________________

   Fruit Group ____________________

   Fats, Oils, and Sweets Group ____________________

3. Each of the food groups is rich in what kind of nutrients?

   Bread and Cereal Group ____________________

   Meat Group ____________________

   Milk Group ____________________

   Vegetable Group ____________________

   Fruit Group ____________________

   Fats, Oils, and Sweets Group ____________________

Name ______________________

4. What do we call the process of breaking food up into nutrients? ______________________

5. What passes from the small intestine into the circulatory system?

____

____

____

6. What happens to nutrients once they are in the circulatory system?

____

____

____

7. How are the following nutrients used in our body?

Carbohydrates ______________________

Fats ______________________

Proteins ______________________

Minerals ______________________

Vitamins ______________________

Water ______________________

8. What is in the waste from our digestive tract?

____

____

DASH

Name__________________________

Date__________________________

STUDENT PAGE 4.5.6 PRESERVING FOOD

1. **Describe how you preserved food.**

2. **Describe what you did in burying the preserved food and predict how it will look when it is dug up. Also predict what the unpreserved food will look like.**

DASH

GRADE FOUR
CLUSTER 6

Health and Safety

4.6.1 Growth Chart and Area Measurement
4.6.2 Tooth Chart
4.6.3 Safety Gear
4.6.4 Safety and Putting Out Fires
4.6.5 Making a Fire
4.6.6 Things That Burn
4.6.7 Smoking and the Lungs
4.6.8 Alcohol, Tobacco, and Drugs

ACTIVITY 4.6.1 GROWTH CHART AND AREA MEASUREMENT

OBJECTIVES

The students
- Measure their height, weight, and hand and foot size.
- Compare their fourth grade measurements with their third grade measurements.
- Predict what their next measurements will be.

BACKGROUND

This activity is the continuation of a DASH sequence on physical growth that begins in kindergarten and continues through grade 6. In it the students measure their height, weight, and hand and foot size. They compare these measurements with those of previous years to get a sense of their own growth and a sense of the variability of growth of people. Some DASH students may have started to graph changes in body dimensions in grade 3. If these graphs are available, have the students add to them. If they are not, have the students start graphing their height, weight, and hand and foot size at this time. Have them also graph the average class height, weight, and hand and foot size.

The activity is the second in the measurement sequence. It should follow Activity 4.10.1 LINEAR MEASUREMENT and precede Activity 4.10.2 VOLUME MEASUREMENT.

STUDENT ROLE

Physician

MATERIALS

Scales
Meterstick
Graph paper
Student Pages 4.6.1A PERSONAL GROWTH CHART
4.6.1B METRIC GRID

PRODUCTS

Growth Charts
Growth Graphs

PROCEDURES

1. **Have the students measure their height, weight, and hand and foot size. Have them use Student Page 4.6.1A PERSONAL GROWTH CHART AND Student Page 4.6.1B METRIC GRID for recording.**

   Have them record
   - Height in centimeters and inches.
   - Weight in kilograms and pounds. (One kilogram is equal to 2.2 pounds.)
   - Foot and hand size in square centimeters.

2. **Have the students graph their measurements to date. If graphs from DASH 3 are available, have the students add to them.**

   Have the students graph some or all the following:
   - Their own height, weight, and hand and foot size for the first measurement of each year they have recorded.
   - Class range of height, weight, and hand and foot size at the beginning of each year.
   - Class average height, weight, and hand and foot size at the beginning of each year.
   - Class change in each dimension from year to year. (From grades K–1, 1–2, 2–3, and 3–4.)

3. **Discuss how the students are growing.**

   Ask such questions as
   - Are there any examples of decreases in height? Weight? (There may be decreases in weight, but unless there has been surgical intervention, there should be no decrease in height.)
   - Has everyone grown the same amount as everyone else? Why might this be so? (Get at the idea that we are all different in the way we grow. There is much variation in human growth.)

- In what grade did we find the greatest increase in height, weight, and hand and foot size?
- Why do the greatest increases seem to come at the same time? (Work to the idea that the body seems to grow as a whole and not in pieces.)
- Which of the measurements shows the greatest overall increase since last year? (This will usually be weight.)
- What do you think your dimensions will be the next time we measure them?

EXTENSION

- Have the students relate clothing and shoe sizes to height and foot measurements.

DASH

Name____________________________

Date____________________________

STUDENT PAGE 4.6.1A PERSONAL GROWTH CHART

		HEIGHT				WEIGHT/MASS			
GRADE	MO/YR	cm	*Change	in	*Change	kg	*Change	lb	*Change

		HAND SIZE		FOOT SIZE	
GRADE	MO/YR	cm^2	*Change	cm^2	*Change

*Change since last measurement

DASH

SP 4.6.1B
METRIC GRID

Name ____________________

Date ____________________

ACTIVITY 4.6.2 TOOTH CHART

OBJECTIVES

The students
- Continue keeping records of the number of teeth they have.
- Continue keeping records of the number of cavities they have.
- Continue keeping records of the number of teeth they have lost.

BACKGROUND

This activity is a companion to Activity 4.6.1 GROWTH CHART AND AREA MEASUREMENT. It continues a record-keeping project begun in kindergarten that involves keeping an ongoing inventory of tooth loss, new teeth, and the appearance of cavities and fillings. Keeping such longitudinal records gives students a sense of natural biological growth and change.

STUDENT ROLE

Dentist

MATERIALS

Mirrors
Student Page 4.6.2 TOOTH CHART

PRODUCTS

Tooth records

PROCEDURES

1. **Introduce the annual tooth inventory to the class.**

   Ask such questions as
   - How many teeth do you think you have now?
   - Has anybody lost a tooth?
   - Which tooth/teeth did you lose?

2. **Review the tooth inventory techniques with the students.**

   Have them
   - On the tooth chart circle the corresponding picture of each tooth they find in their mouths.
   - Blacken in any gap.
   - Put an (X) on all teeth that have cavities, fillings, or caps.

3. **Have the students verify each other's observations.**

4. **Collect class data.**

   Ask such questions as
   - How many natural teeth do you now have?
   - How many teeth have you lost? Have you gained any teeth?
   - What is the size of the new teeth compared to the size of the old teeth?
   - How many cavities have you now? How many did you have last year?
   - How many cavities do you have in new teeth? How many did you have in new teeth last year?
   - How many cavities do you have in old teeth? How many did you have last year?

5. **Summarize the activity and have the students make bar graphs of the class data.**

EXTENSION

- Have the students make a large diagram of teeth and their proper names.

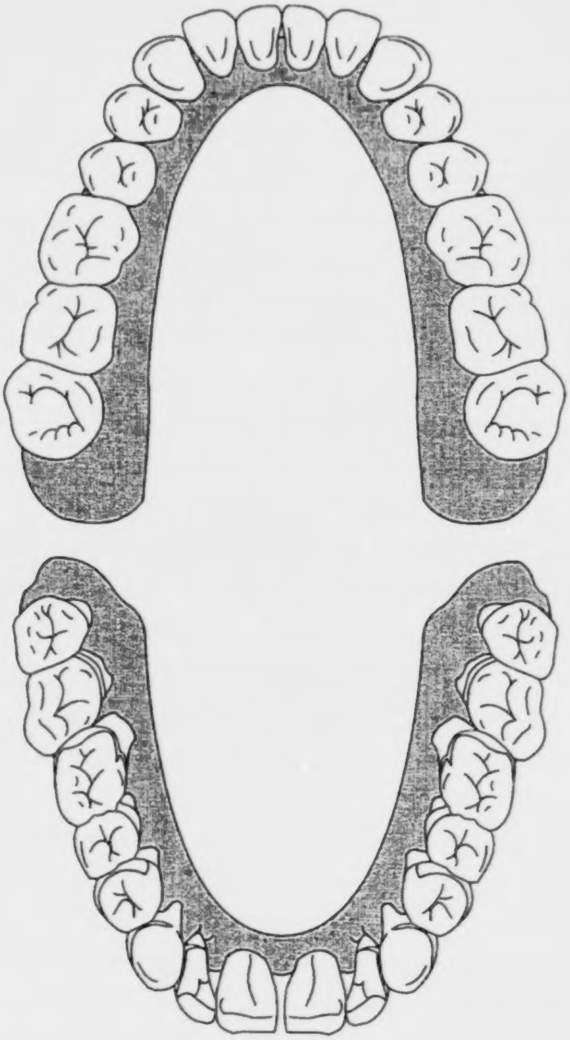
DASH

Name____________________________

Date____________________________

STUDENT PAGE 4.6.2 TOOTH CHART

Blacken any missing teeth. Circle any new teeth. Put an (X) on any teeth with cavities, fillings, or caps.



ACTIVITY 4.6.3 SAFETY GEAR

OBJECTIVES

The students
- Invent and make garbage bag raincoats.
- Invent and make protective aprons.
- Invent and make devices to handle hot and cold materials safely.
- Invent and make eye shields.

BACKGROUND

Safety is a constant concern in DASH. To make the students aware of things that are potentially dangerous, they make their own protective gear. They are made responsible for determining when such gear should be used and its limitations in protecting them. This, of course, does not take the primary responsibility for safety off the teacher, but it does provide many hands and eyes—all trained to help identify hazards and deal responsibly with them.

It is suggested that special safety equipment be produced when it is needed.

Items in the DASH safety equipment package are
- A safety team. Two or more students should be appointed each week to watch for safety problems and inform the teacher when safety precautions should be taken.
- Garbage bag raincoats. DASH students have probably been making emergency raincoats from plastic garbage bags since kindergarten. Raincoats need not be made until there is a time when some students do not have adequate covering to work in the rain. The design should be the responsibility of the students. Utility should be stressed. The raincoats should be dried after use, folded, and stored for other emergency occasions.
- Garbage bag aprons. All students should have garbage bag aprons for work in the classroom and field. They should design their own aprons, keeping utility in mind. The aprons should be cleaned after use and stored.
- Hot/cold pads and other devices for handling hot and cold materials. The students should invent devices for handling hot and cold materials. These devices should be cleaned and stored after use.

- Eye shields to protect against liquids. A design for an eye shield made from a plastic bottle is shown in Figure 4.6.3. The students should have the latitude to create eye shields that are comfortable.

STUDENT ROLES

Safety officer
Inventor
Safety-conscious worker

MATERIALS

Quality plastic bags, 20–30 gal
Cloths to make pads
Heavy-duty twine
Plastic jugs, 2-gal size (milk, bleach, etc.)
Clear-plastic 1-gal soda bottles for window materials (Any heavy-duty clear plastic will do.)
Duct tape
Rubber bands
Scissors
Razor-sharp knife to make first cuts in plastic (TEACHER'S CONTROL)
Student Page 4.6.3 SAFETY GEAR

PRODUCTS

Raincoats
Aprons
Hot/cold pads and other devices for handling hot and cold materials
Eye shields for protection against liquids.
Completed Student Pages

PROCEDURES

1. Develop a concept map about classroom hazards.

Help the students include such things as

- Slippery floors.
- Hot things, cold things.
- Things that can get into our eyes.
- Things that can make us stumble.
- Sharp and pointed things in our desks.

- The way equipment is used.
- Playing while working with sharp tools.
- Things that can fall over.
- Clothes that get wet, chilling us so that we catch colds.
- Drains that get clogged so that water runs over the sink, making us fall.
- Clutter that can make us trip and fall.
- Blocked exits.

2. **Use the concept map as a starting point and have the class write safety rules.**

3. **Introduce the idea that each week the class will have a new safety team. Announce the members of the first safety team. At the end of the week, have members of the team report on what they have done during their time in office.**

4. **When a project calls for covering the clothes to prevent staining, have the students invent aprons.**

   Ask such questions as
   - What can we use to make aprons? (Work for agreement that aprons can be made from plastic bags.)
   - What do we do with our aprons once we have used them? (Get agreement that we clean and store them for later use.)

5. **When a project calls for working outside in the rain, have students who have no raincoats invent and make them.**

   Ask such questions as
   - What can we use to make raincoats? (Work for agreement that raincoats can be made of plastic bags.)
   - What precautions do we need to take when we put a plastic bag over our head? (Get at the need for air holes.)
   - What do we do with our raincoats once we have used them? (Get agreement that we clean and store them for later use.)

6. **When a project calls for handling hot or cold materials, have the students invent hot/cold pads or other handling devices.**

Ask such questions as

- What can we use to make devices to handle hot or cold things? (Work for agreement that the devices should be made of things that are not destroyed by extreme temperatures. At lower temperatures, cloth or wood might be used. At higher temperatures, metal or ceramic materials should be used.)
- What do we do with our devices once we have used them? (Get agreement that we should clean and store them for later use.)

7. **When a project calls for students to handle liquids that might get into their eyes, have them invent eye shields. Show them a prototype.**

The following things should be taken into account:

- The shields should have a wide angle of view. The plastic windows should be wide and broad enough for the students to look in all directions.
- The plastic windows should be liquid-proof so that no liquid comes in directly or around the sides.
- All shields should be tested for waterproofing.
- The shields should be secure so that they will not slip off the head. This can be achieved by using rubber bands.
- After use, the shields should be cleaned, inspected, and stored.

EXTENSION

- Have the students design other safety equipment, including storage systems as needed.

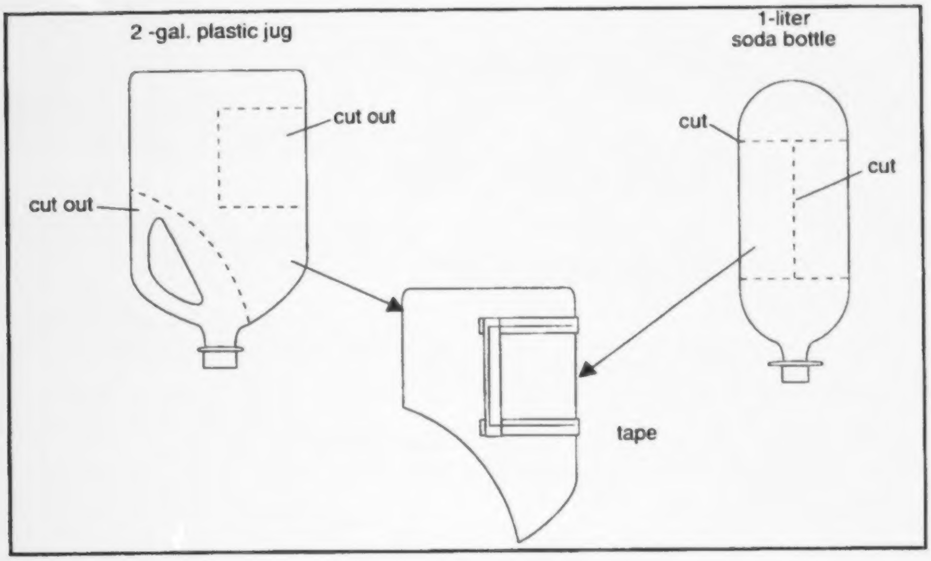

2 -gal. plastic jug
1-liter
soda bottle
cut out
cut out
cut
cut
tape

Figure 4.6.3 Eye shield

DASH

Name________________________

Date________________________

STUDENT PAGE 4.6.3 SAFETY GEAR

1. Show your design for an eye shield that protects against liquids.

2. Describe how your shield protects your eyes.

____

____

____

____

____

____

ACTIVITY 4.6.4 SAFETY AND PUTTING OUT FIRES

OBJECTIVES

The students
- Make a concept map about fire.
- Find ways of handling hot objects in a game format.
- Review first aid rules for treating burns.
- Investigate the three things necessary to start a fire—fuel, oxygen, and heat.
- Observe ways to put out fires.

BACKGROUND

This activity is the first in a sequence on energy, chemistry, and fire. It should be followed by 4.6.5 MAKING A FIRE, 4.6.6 THINGS THAT BURN, 4.10.13 AIR AND FIRE, 4.10.14 FIRE AND OXYGEN, and 4.10.15 PROPERTIES OF GASES. Ideally, these activities can be tied to Fire Prevention Week.

There are six parts to the activity. In the first the students review what they already know about fires by making a concept map. In the second part, they review fire safety rules using Student Page 4.6.4A FIRE SAFETY AT SCHOOL. In the third part, five situations in which hot things are handled are outlined. The students are divided into groups to play a game in which they devise a way to handle hot objects safely. Each way should be different from the last one given and should be accompanied by a reason for the solution.

In the fourth part of the activity, the proper treatment of burns is discussed. In the fifth part, the students explore essentials for making a fire. Finally, in the sixth part they identify ways of putting out fires.

At this time some students will be in organizations in which making and controlling fire is a major part of the training. Where possible use their expertise. Fire will be frightening to some students. Many will be ignorant of such basics as to how to strike a match. Wood kitchen matches are suggested for introduction to match lighting. A dry stone can be used as a scratch surface. Later, matchbook safety matches can be introduced.

STUDENT ROLES

Fire fighter
Householder

MATERIALS

Fireproof pan to hold burning materials
Paper
Matches
Hand lenses
Water to put out fires
Jar to cover burning paper
Student Pages 4.6.4A FIRE SAFETY AT SCHOOL
4.6.4B FIRE SAFETY

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Have the students make a concept map of the term "fire."**

   Help them include such things as
   - Things that burn.
   - Where fires are controlled. (In stoves, fireplaces, furnaces.)
   - Fires that are out of control. (House, forest, and range fires.)
   - Ways of starting a fire.
   - Ways of putting out a fire.
   - Fire safety.

2. **Set the stage for the activity by explaining that the class is going to be studying fire and how it is used. Before beginning it is necessary to learn more about how to work safely with fire. Use the safety rules on Student Page 4.6.4A FIRE SAFETY AT SCHOOL.**

Be sure the discussion includes
- How to put out a fire. (Explain how to use a fire extinguisher and water.)
- What to do if someone catches on fire. (One should roll on the ground, NOT run.)
- The safety rules to be used at school.

3. **Present ways to handle hot things by having the students play a problem-solving game.**

Divide the class into teams. There are many answers to each problem, and each team should offer a different answer.

Situation A. There is a hot skillet that has to be removed from the stove.
- How do you move it without getting burned?
- Why would you do it that way?

Situation B. There is a pitcher-shaped container filled with hot melted wax. The wax must be poured into a candle mold.
- How would you hold the container to pour the hot wax without getting burned?
- Why would you do it that way?

Situation C. In the Pacific islands, stones are heated in a fire and then used to cook a pig. The stones are put into the body cavity of the butchered pig that is then wrapped in banana leaves and buried in a pit. After 5–6 hours the meat is cooked and ready for eating.
- How would you move the hot stones from the fire to the pig without getting burned?
- Why would you do it that way?

Situation D. Early pioneers put burning coals into a metal pan to warm cold beds.
- How would you get the burning coals from the fire to the bed warmer without getting burned?
- How could you keep from burning the sheets? (Move the warmer as you would an iron.)
- Why would you do it that way?

Situation E. You are given melted glass in a ceramic pottery cup. It is so hot that it would set cloth, leather, wood, or plastic on fire. You must pick up the extremely hot cup and pour the contents into a glass mold that is across the room.

- How would you pick up the cup, carry it, and pour out the contents without getting burned?
- Why would you do it that way?

Add other situations as desired.

4. **Go over first aid practices to be used in case of a burn.**

- Get the person away from the fire or the thing that produced the burn.
- Get an adult's help if possible.
- If the skin is red or blistered, run cool water over the burned area.
- If the skin is blackened or burned through, **call 911** for instructions.

5. **Discuss what the students think is required for a fire to start. Have the students demonstrate how to set a piece of paper on fire.**

Ask such questions as

- What do we need to start a fire? (Get at the idea of something to burn [the paper] and something to get the fire started [the match]. Have someone demonstrate setting paper on fire.)
- What does the match do? (Get at the idea of getting the paper hot enough to burn.)
- Can we heat the paper some other way to see whether heat starts the burning? (If no one responds, suggest using a hand lens, an electric heating coil, friction, and so forth.)
- How could we use a hand lens to start a fire? (Have the students demonstrate how to make paper burn by concentrating the heat from the sun.)
- What does the hand lens seem to do to the heat from sunlight? (Get at the idea that it concentrates the rays of the sun.)
- We have found that we need something to burn and something hot to start the fire. Anything else? (Work toward the idea that the paper is in air.)

- What do you think would happen if we kept fresh air from getting to the fire?
- How could we test to see? (Get at the idea of putting something over the fire to keep out the air.)

6. Light a piece of paper and put a jar over it.

Ask such questions as
- What happened to the fire?
- What did you see inside?
- What three things seem to be necessary for burning to take place?

7. Discuss and demonstrate how to put out fires.

Ask such questions as
- Can anyone think of a situation in which we stop a fire by taking away the things that burn (fuel)? (List such things as turning off the gas in a stove or heater and making firebreaks when fighting fire in the woods.)
- Can anyone think of a situation in which we put out a fire by cooling it? (One example is when we put a lighted match on ice-cold metal. Demonstrate. Make a list of situations in which fire is cooled and put out.)
- Can anyone think of a situation in which we put out a fire by keeping the fresh air away? (Make a list of situations such as putting something that won't burn over the paper.)
- When people have their hair or clothes catch on fire, we put out the fire by rolling them on the ground or tossing a blanket over them. How does this put out the fire? (It deprives the fire of air and cools it.)

8. Review the activity using Student Page 4.6.3B FIRE SAFETY.

EXTENSIONS

Have the students
- Keep newspaper clippings about fires and analyze how the fires were put out.
- Invite a fire fighter to talk about fire safety and demonstrate ways to put out fires. Discuss how each method involves one or more ways of depriving a fire of heat, air (oxygen), or fuel.

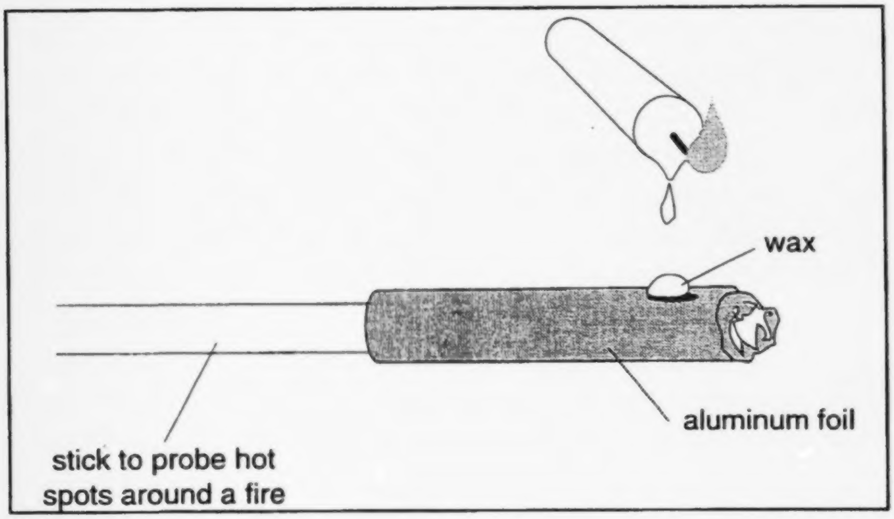

wax
aluminum foil
stick to probe hot spots around a fire

Figure 4.6.4 Heat probe

DASH

Name______________________________

Date______________________________

STUDENT PAGE 4.6.4A FIRE SAFETY AT SCHOOL

1. WHEN WORKING WITH FIRE, BE SURE YOUR TEACHER OR OTHER AUTHORIZED ADULT IS PRESENT.

2. WHEN WORKING WITH FIRE, BURN ONLY THINGS THAT HAVE BEEN OKAYED BY YOUR TEACHER.

3. WHEN WORKING WITH FIRE, BE SURE ONLY ONE FUEL MATERIAL IS IN YOUR WORK AREA.

4. WHEN WORKING WITH FIRE, WEAR EYE PROTECTION.

5. WHEN WORKING WITH FIRE, HAVE ON HAND A FIRE-EXTINGUISHING DEVICE YOU KNOW HOW TO USE.

6. WHEN WORKING WITH FIRE, TIE YOUR HAIR SO THAT IT IS AWAY FROM YOUR FACE.

7. WHEN WORKING WITH FIRE, WORK WITH ONE OR MORE PARTNERS.

8. WHEN WORKING WITH FIRE, FOLLOW ALL DIRECTIONS CAREFULLY.

DASH

Name________________________

Date_________________________

STUDENT PAGE 4.6.4B FIRE SAFETY

1. List the things that should be done for a person who has been burned.

2. What must we have to start a fire?

3. List ways we can put out a fire. For each way listed tell what is being controlled—temperature, air, or fuel.

ACTIVITY 4.6.5 MAKING A FIRE

OBJECTIVES

The students
- Discuss ways to start a fire.
- Practice starting a fire.

BACKGROUND

This activity is the second in a series on energy, chemistry, and fire. It should be done after 4.6.3 SAFETY GEAR and 4.6.4 SAFETY AND PUTTING OUT FIRES and come before 4.6.6 THINGS THAT BURN. Wherever possible, the students should light their fires without using matches. The activity provides an important piece in the survival theme started in Activity 4.1.9 SURVIVAL GAME.

NOTE: Everyone should wear eye shields. Long hair should be tied back from the face.

MAKING A FIRE is designed as an outdoor activity to be done on a relatively warm and windless day.

Teacher Supervision

All work with fire should be done under the teacher's control and supervision. Several ways of starting fires are explored in this activity. Many of the students will have worked with fire at home and in organizations such as Girl Scouts and Boy Scouts. Others will never have made a fire and may be afraid of it. The emphasis must be on safety and control. Where possible, students who have worked with fire should work with those who have not. Fire activities should be done only after the students have demonstrated the ability to work responsibly.

Working Groups

The students can work in groups of four: two experimenters, one recorder, and one safety monitor to make sure the group is following instructions.

Fire Pans

It is suggested that all fires be made in a fire pan, a metal pan filled with sand or dirt. This will limit the size of the fire and make clean-up easier.

Using a Bow and Fire Drill
Using a bow and fire drill is difficult and should (when possible) be demonstrated by a Scout or someone else who has experience. Try all methods ahead of time so you can help students. The steel wool can be held to the battery poles with sticks.

STUDENT ROLES

Camper
Householder
Safety officer

MATERIALS

Fire pan (large metal or aluminum pie pans)
Sand or earth to fill and insulate metal pans
Tinder (pounded dry cedar or cottonwood bark, coconut husks, dry charred cloth)
Paper
Kindling
Charcoal
Fire starters (matches, hand lenses, flint and steel, battery and steel wool, rubbing sticks, etc.)
Buckets of water to put out flames
Rubber bands to tie hair back
Eye shields
Student Pages 4.6.5A WAYS TO START A FIRE
4.6.5B MAKING A FIRE

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Set the stage for the activity by telling the students that the class is going to do a series of things that require the use of fire and must first investigate ways to start a fire. Explain that some fire-starting techniques that don't require matches will be investigated.**

Ask such questions as
- How can we start a fire?
- What is tinder?
- What is kindling?
- What is maintenance fuel?
- Does anyone know how to build a fire so that it can light large pieces of wood or charcoal?
- What do you have to do to build such a fire?

2. **Have the students read the background information on Student Page 4.6.5A. Divide the students into teams.**

   Have the students
   - Discuss fire safety, emphasizing the role of the safety monitor.
   - Select a way to start a fire.
   - Gather materials to start a fire.
   - Gather safety equipment, including eye shields, fire pans, and buckets of water.

3. **Take the students outside and have them work in a circle so you have access to all groups. Your degree of control will be determined by the number of groups working at any one time. Greatest control will be achieved by having one group work while the others watch.**

4. **Have the groups practice starting a fire using their chosen method. Have them demonstrate their method.**

5. **Have the students build a fire to ignite charcoal.**

   Have them
   - Ignite tinder and kindling
   - Use tinder and kindling to ignite a piece of charcoal.
   - Invent a way to extinguish the burning charcoal safely.
   - Report how they lit their charcoal and extinguished the burning charcoal.

6. Summarize the activity.

Ask such questions as
- How did you start your fire?
- What problems did you have?
- What role did the tinder play?
- Why did the tinder catch fire so easily?
- How might we get a big piece of wood to burn?
- Why are bare electrical wires so dangerous?
- Why is it dangerous to have loose paper around a stove?
- Why did we have a safety monitor?
- How might we get a big piece of wood to burn?
- Can anyone show us how this might be done?
- Which of the methods we have used might have been used by indigenous peoples?
- How would you try to start a fire if your were alone in the wild without matches or any fire-starting equipment?

EXTENSIONS

Have the students
- Read the newspapers, watch TV, and talk to parents and friends to find ways fires have been started accidentally.
- Research how people produced fire before matches were invented.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.6.5A WAYS TO START A FIRE

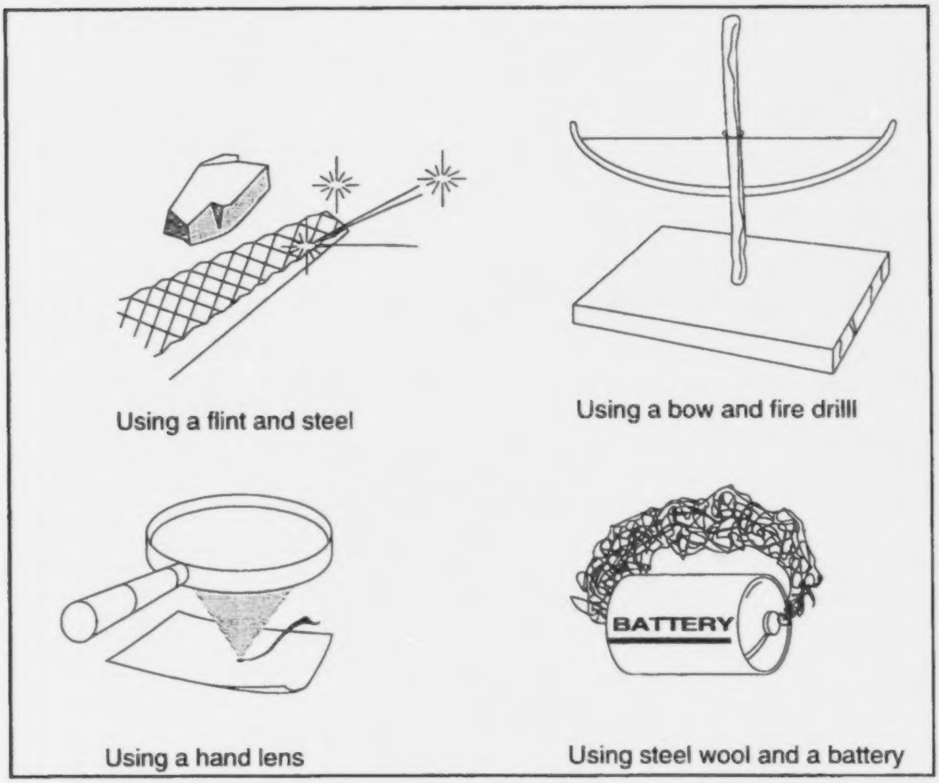
Fire is one of the most useful natural processes we humans have learned to control. It is also one of the most dangerous. A controlled fire can cook our food, heat our homes, fire pottery, and change ore into streams of pure metal. An uncontrolled fire can burn down homes, forests, entire cities, and it can burn and kill us.

Because we humans have learned how to control fire, it can be handled quite safely. However, we must always be sure we are safety conscious when we work with it. To help ensure safety, a safety monitor will be appointed in each working group.

We now need to find out how we can start a fire. Four ways are shown in Figure SP 4.6.5A:

- Using flint and steel. Here a shower of sparks is produced that will start tinder burning. Blowing gently on the glowing tinder will produce a visible flame.
- Using a bow and fire drill. The drill produces heat at the fire hole in the base. Tinder touching the base will start to smolder and visible fire will burst out when it is gently blown on.
- Using a hand lens. A hand lens can focus light rays of the sun on tinder, heating it to its smoldering point.
- Using steel wool and a battery. The steel wool connects the poles of a dry cell. Electricity passing through the steel wool heats it to glowing. The hot wool can then be touched to tinder which will burn. A way has to be found to hold the steel wool to the poles so that the hot wool does not touch your fingers.

Name ______________________



Using a flint and steel

Using a bow and fire drilll

Using a hand lens

Using steel wool and a battery

Figure SP 4.6.5A Ways of starting a fire

DASH

Name________________________

Date_________________________

STUDENT PAGE 4.6.5B MAKING A FIRE

Describe how fires were started in your class investigations.

ACTIVITY 4.6.6 THINGS THAT BURN

OBJECTIVES

The students
- List the things they want to know about fire.
- Review fire safety.
- Study the nature of fire through experimentation and demonstration.

BACKGROUND

This activity is the third in a series on energy, chemistry, and fire. It should be preceded by Activities 4.6.3 SAFETY GEAR, 4.6.4 SAFETY AND PUTTING OUT FIRES, and 4.6.5 MAKING A FIRE. These three activities should all be done before 4.10.12 FIRE AND POTTERY, 4.10.13 AIR AND FIRE, 4.10.14 FIRE AND OXYGEN, and 4.10.15 PROPERTIES OF GASES.

In this activity the students systematically test a wide range of materials to see whether they will burn and test their own hypotheses about fire. The two kinds of tests can be done separately.

Precautions

Some general precautions should be taken:
- All testing to see whether substances will burn must be done under the teacher's control.
- All testing should be done outside on a warm windless day.
- Everyone should wear eye protection, and long hair should be tied back from the face.
- Test only substances you know about. Substances such as gun powder and nitrate fertilizers explode and should not be tested.
- Always use small quantities of materials in testing.
- Carry liquids in small containers. Samples should be no larger than 5 or 6 mL.
- Use small candles as fire sources.
- If possible, work in a shaded area so that flames can be clearly seen.

Working Groups

The students can work in groups of four: two experimenters, one recorder, and one safety monitor to make sure the group is following instructions.

Test Items
Some liquids you may want to test for flammability are cooking oil, alcohol, gasoline, hair oil, motor oil, water, detergents, lighter fluid, and corn syrup. Some solids you might test are wood, hair, wax, fruit, chicken skin, metals, fat, lean meat, salt, rocks, pottery, concrete, plaster, glass, cloth, plastic, and coal.

Test Procedures
- Test the flammability of liquids by pouring several milliliters of liquid into a saucer and then bringing a candle flame next to it. Some flames are almost colorless and are best seen in the shade.
- Test small pieces of solid by placing them directly in a flame. Have the students invent a metal holder from aluminum or other metals.
- Test the hotness of the flame with a series of solidified wax drops on a piece of aluminum foil. Hold the foil in the area being tested and time how long it takes to melt the wax. See Figure 4.6.6.
- Test any hypotheses about winds with smoke or fine thread.

STUDENT ROLES

Chemist
Safety officer

MATERIALS

Fire pan
Sand to hold candles
Things that students think will burn
Baby food jars with lids to carry liquids into the field
Shallow saucers to the test the flammability of liquids
Aluminum foil
Coat hangers to make a frame for a wind shield
Candles
Watch
Sticks to hold things near the fire
Pliers
Large paper clips
Fire starters (matches, hand lenses, steel file and flint, battery and steel wool, rubbing sticks, etc.)
Buckets of water to put out flames
Rubber bands to tie hair back
Eye shields
Thread

Student Pages 4.6.4A FIRE SAFETY AT SCHOOL
4.6.6 FIRE OBSERVATIONS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Set the stage by explaining that the class is going to investigate things that burn. Have the students make a list of their questions about fire on Student Page 4.6.6 FIRE OBSERVATIONS. Have them list what they might look for to answer their questions and, where possible, what they think the answers to their questions will be.**

   Help them include such questions as
   - What kind of things will burn? (Have the students list things that they think will burn, things that won't burn, and things they are not sure of.)
   - How could we safely test what will burn? (See Background.)
   - Where around the fire is it hottest—around the side, on top, or below?
   - How can we test to find the hottest area around the fire?
   - How close can we get our hands to the fire before we begin to feel heat?
   - What does blowing on a fire do to it?
   - Does the fire respond differently to gentle and hard blowing? When?
   - Where does the smoke go?
   - Why does the smoke move as it does?

2. **Go over the fire safety procedures on Student Page 4.6.4A FIRE SAFETY.**

3. **Help the students develop testing procedures to find things that burn and things that don't. Describe the technique of testing liquids on a saucer and using a candle as a flame source.**

Have the students
- Invent a holder for solids.
- Invent ways of carrying out their investigations
- Demonstrate what they will do in the field before going out.
- Set up safety procedures, including working in a circle.

4. **Have the students organize and carry out investigations to answer their questions.**

5. **Have the students summarize the investigation on Student Page 4.6.6 FIRE OBSERVATIONS and report on their findings.**

Ask such questions as
- What kinds of things burn? (Get at the idea that most come from once-living things.)
- What kinds of things don't burn? (Get agreement that most non-living things don't burn.)
- What might indigenous people have used to make fires?

EXTENSIONS

Have the students
- Add to the list of things that burn and things that do not.
- Make a list of places where fire is used in the home.
- Make a list of places where fire is used in industry.

Name________________________

Date________________________

STUDENT PAGE 4.6.6 FIRE OBSERVATIONS

1. List your questions, your predicted answers, and what your research showed about fire.

QUESTIONS	PREDICTIONS	FINDINGS

2. Describe a fire in terms of its temperature. Tell where it is hottest and coldest.

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Name ______________________

3. Describe the kinds of things that burn.

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4. Describe how the air moves around a fire.

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ACTIVITY 4.6.7 SMOKING AND THE LUNGS

OBJECTIVES

The students
- Make an artificial lung.
- Identify some of the components of cigarette smoke.
- Compare the gas normally exhaled from the body with smoke from cigarettes.

BACKGROUND

This activity follows 4.10.13 AIR AND FIRE, 4.10.14 FIRE AND OXYGEN, and 4.10.15 PROPERTIES OF GASES.

The students first make an artificial lung and then identify similar structures in their own lungs. Next a cigarette is burned and the gas produced is washed in water. The washed gas is then subjected to a series of tests to see how cigarette smoke compares with normally exhaled air.

The Lung

An artificial lung can be made from a quart-size plastic soda bottle with its bottom cut off and a smaller glass or plastic soda bottle that will fit inside. See Figure 4.6.7(1). Wrap the body of the smaller bottle with cloth to make a sliding piston. The piston can be made reasonably air tight by wetting the cloth. Set up the system shown in Figure 4.6.7(2). Attach a short piece of plastic tubing using a sponge cork. A cigarette can be attached to the tubing with tape.

Operating the Lung

Draw in the smoke and a yellowish scum of cigarette tar will be deposited on the wall of the first chamber. This tar will have to be washed off with soap. It is this tar that destroys the lungs.

Limewater

To make limewater, pour about 2 tablespoons of calcium oxide (quicklime also called builder's lime) into a 1-liter or 1-quart jar. Shake the jar for 2 minutes and let the solid settle out. Limewater is a clear liquid. Seal the jar to keep out carbon dioxide (CO_2) gas that will form a white scum or cloud in the water. If scum forms, it can be wiped off the surface of the liquid with a paper towel.

STUDENT ROLE

Chemical researcher

MATERIALS

Cigarettes (with and without filters)
1 plastic soda bottle (1-liter or 1-quart)
3 plastic soda bottles (2-liter or 2-quart)
Cloth for wrapping piston
Candle
Matches
Limewater
Hydrion pH strips
Stopper of cloth or sponge.
Plastic tubing
Student Page 4.6.7 SMOKE AND THE LUNGS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Show the students a prototype artificial lung and have them make one.**

2. **Have the students compare the action of the artificial lung with the action of our lungs. Review the parts of the lungs.**

   Ask such questions as
   - How is the artificial lung different from our lungs? (Work for such ideas as the artificial lung represents only one of the two lobes of our lungs and the artificial lung is plastic while our lungs are flesh—a network of passages and chambers, veins, and arteries.)
   - How is the artificial lung similar to our lungs? (Work for such ideas as they both have a movable wall—the diaphragm in the lungs and the plunger in the artificial lung—that draws in air and pushes it out.)
   - What do we mean by a simulation? (Get at the notion that one thing is used to act like another thing. Usually there is a close resemblance of some features.)

- What part of the artificial lung system corresponds to the trachea? (The neck of the bottle.)
- What part of the artificial lung system corresponds to the chest? (The outside surface of the bottle.)
- What part of the artificial lung system corresponds to the air spaces inside our lungs? (The space within the bottle.)
- What part of the artificial lung system corresponds to the diaphragm? (The piston.)

3. **Set up the system so that the artificial lung can draw smoke from a cigarette through the water.**

Have the students observe the

- Color of the liquid after the gas has passed through the liquid.
- Acidity. (The water the smoke has passed through will test acid with pH paper.)
- Capacity to support combustion. (The gas will still support combustion; a candle will still burn in it.)
- Flammability. (Not flammable.)
- Reaction with limewater. (A precipitate forms indicating the presence of CO_2.)

4. **Have the students blow through the system. Have them compare the exhaled gas with cigarette smoke.**

5. **Summarize the activity.**

Include such questions as

- How are the results from gas tests for cigarette smoke similar to tests for air normally exhaled from the lungs? (Both test positively for carbon dioxide.)
- How do the results from the gas tests on cigarette smoke differ from tests on air normally exhaled from the lungs? (The cigarette smoke has a tar-like material.)
- What could happen to the tissue of your lungs if they were exposed to cigarette smoke for a long period of time? (Get at the idea that the tar could build up. Add that it is the tar that irritates the lungs, that it can destroy lung tissue, and in some cases, produce cancer.)
- Do lungs normally take all of the oxygen out of the air that is inhale? (Only a small amount of the oxygen is normally removed in breathing as shown by the fact that the gas exhaled still supports combustion.)

- If carbon dioxide is one of the natural products of the lungs, what is being converted to carbon dioxide? (Have the students note that carbon dioxide is produced from burning vegetable matter, animal matter, and gases such as butane and methane (stove gas). We take into our bodies food that is mostly vegetable and animal matter. Help the students hypothesize that the food we eat might be "burned" in our bodies.)

EXTENSION

- Have a doctor or other health service person discuss the hazards of smoke and smoking.

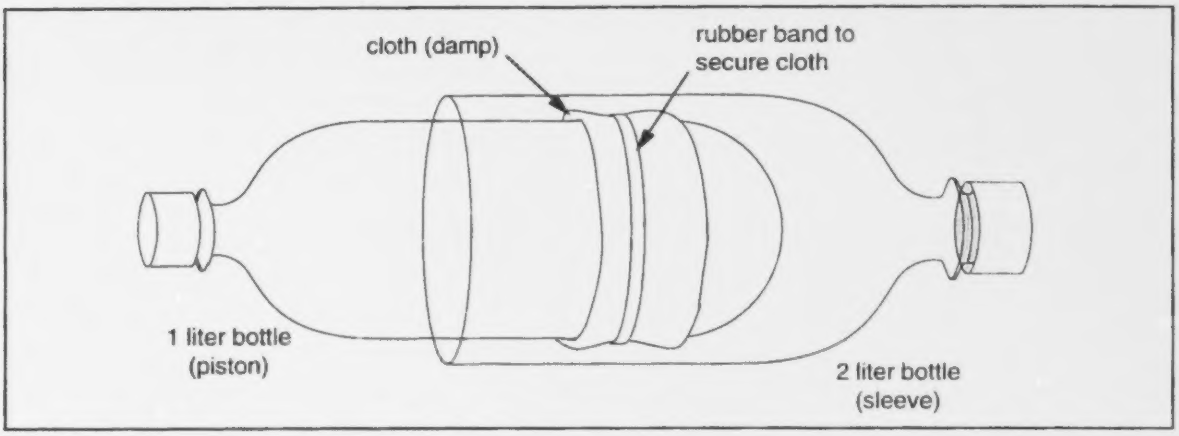
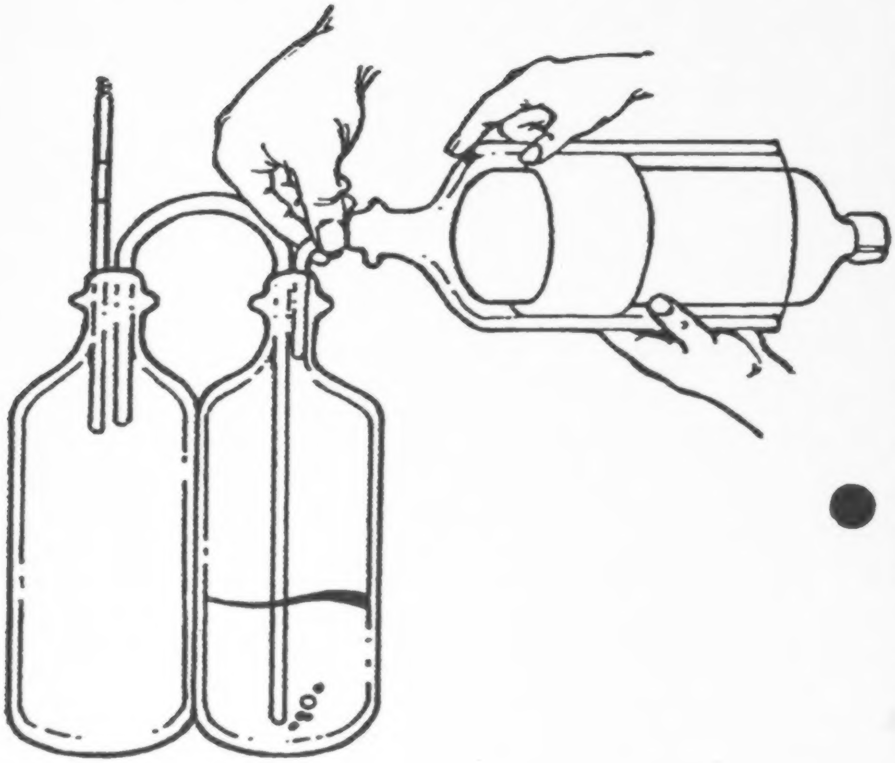

cloth (damp)
rubber band to secure cloth
1 liter bottle (piston)
2 liter bottle (sleeve)

Figure 4.6.7(1) Syringe lung

743



The piston is pulled when the exhaust hole is closed. Air flows through the water. To return the plunger, open the exhaust hole, pinch the finger valve, and return the plunger.

Figure 4.6.7(2) System to wash cigarette smoke

DASH

Name__________________________

Date__________________________

STUDENT PAGE 4.6.7 SMOKE AND THE LUNGS

1. Draw your simulated lung and label the trachea, chest, lung, and diaphragm.

2. Describe how you transferred exhaled air to the bottles of water.

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Name ______________________

3. **Compare the results of your tests on cigarette smoke and on air exhaled normally from the lungs.**

ACTIVITY 4.6.8 ALCOHOL, TOBACCO, AND DRUGS

OBJECTIVES

The students
- Collect information about alcohol, tobacco, and nontherapeutic drugs.
- Identify problems associated with alcohol, tobacco, and drugs.

BACKGROUND

This activity starts the students on a three-year search for information bearing on the worldwide concerns about use of alcohol, tobacco, and nontherapeutic or recreational drugs. The students start to collect data in grade 4 to set the stage for more intensive study of these three concerns in grades 5 and 6. They make scrapbooks of articles that deal with both the positive progress and the negative losses of society's struggle. Scrapbooks should be saved in the library for use in grades 5 and 6.

Fourth grade students frequently have difficulty understanding newspaper articles. Often the vocabulary used in newspapers is beyond their initial understanding. Further, newspaper articles often rely on a body of "common knowledge" that students may not have encountered. For these reasons it will be important to ask parents to help their children read and understand the articles. This will also provide a way of getting parents to talk with their children about these very sensitive topics. Over time the students will become well enough acquainted with the language and history of these concerns to become independent readers and interpreters.

STUDENT ROLE

Researcher

MATERIALS

Newspapers
Three scrapbooks
Glue
Student Page 4.6.8 ALCOHOL, TOBACCO, AND DRUGS

PRODUCTS

Scrapbooks
Completed Student Pages

PROCEDURES

1. **Introduce the topics of alcohol, tobacco, and nontherapeutic drugs by explaining that we need to get some idea of why they are such important social concerns. Have the students make separate concept maps based on their current understanding of these concerns.**

   Help them include such things as
   - Addiction.
   - Illegality.
   - Health hazards.
   - Disease.
   - Habit formation.
   - Habit breaking.
   - Physiological damage.
   - Psychological damage.
   - Crime.

2. **Store the concept maps for later additions and corrections.**

3. **Explain to the students that in order to collect information the class will make three scrapbooks—one for drugs, one for alcohol, and one for tobacco.**

   Every week the students will put into each of these scrapbooks
   - One or more articles that deal with the negative side of the problem. (Deaths, medical reports of problems, increases in the extent of use, and so forth.)
   - One or more articles that deal with the positive side of the problem. (Medical reports of treatments, enforcement successes, programs to fight addiction, and so forth. When possible, articles that report results of research and provide factual data relevant to the topic should be included.)
   - A summary of each article that will be the basis of a class report.

4. Once each week have a student or group of students report on new additions to the scrapbooks.

Be sure the reports include such things as
- The origin of the article.
- What the article is about.
- Who the article was about (when appropriate).
- When the events described happened.
- How the article connects to what we have learned earlier.
- What implications the things described have for us.

5. At the end of the year summarize with the students the contents of the three scrapbooks. Have them correct or flesh out the concept maps made earlier and complete Student Page 4.6.8 ALCOHOL, TOBACCO, AND DRUGS.

The students can work in groups to compile and summarize data on one topic, for example, local social problems with alcohol, national research on tobacco, international drug enforcement, and so forth.

Review such questions as
- What are the medical problems with alcohol, tobacco, and nontherapeutic drugs?
- What are the problems on an international level?
- What are the problems on a national level?
- What are the problems on a local level?
- What is being done on an international level?
- What is being done on a national level?
- What is being done on a local level?

6. Place the scrapbooks in the library for use in grade 5.

EXTENSION

- Have the students write an essay on the distinction between therapeutic drugs and illegal drugs.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.6.8 ALCOHOL, TOBACCO, AND DRUGS

1. Summarize the medical, social, psychological, and economic problems involved with alcohol, tobacco, and nontherapeutic drugs.

Name ______________________

2. **Summarize the problems on the international, national, and local levels and tell what is being done about them.**

DASH

Name________________________

Date________________________

STUDENT PAGE 4.6.1A PERSONAL GROWTH CHART

		HEIGHT				WEIGHT/MASS			
GRADE	MO/YR	cm	*Change	in	*Change	kg	*Change	lb	*Change

		HAND SIZE		FOOT SIZE	
GRADE	MO/YR	cm^2	*Change	cm^2	*Change

*Change since last measurement

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DASH

SP 4.6.1B
METRIC GRID

Name ____________________

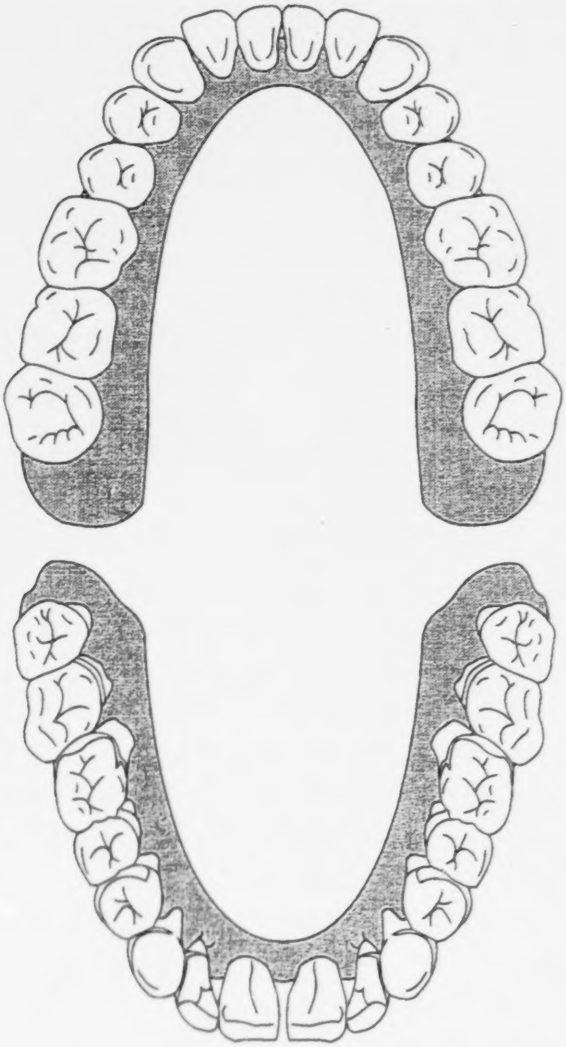
Date ____________________

Name______________________

Date______________________

STUDENT PAGE 4.6.2 TOOTH CHART

Blacken any missing teeth. Circle any new teeth. Put an (X) on any teeth with cavities, fillings, or caps.



Name______________________

Date______________________

STUDENT PAGE 4.6.3 SAFETY GEAR

1. Show your design for an eye shield that protects against liquids.

2. Describe how your shield protects your eyes.

DASH

Name______________________

Date______________________

STUDENT PAGE 4.6.4A FIRE SAFETY AT SCHOOL

1. WHEN WORKING WITH FIRE, BE SURE YOUR TEACHER OR OTHER AUTHORIZED ADULT IS PRESENT.

2. WHEN WORKING WITH FIRE, BURN ONLY THINGS THAT HAVE BEEN OKAYED BY YOUR TEACHER.

3. WHEN WORKING WITH FIRE, BE SURE ONLY ONE FUEL MATERIAL IS IN YOUR WORK AREA.

4. WHEN WORKING WITH FIRE, WEAR EYE PROTECTION.

5. WHEN WORKING WITH FIRE, HAVE ON HAND A FIRE-EXTINGUISHING DEVICE YOU KNOW HOW TO USE.

6. WHEN WORKING WITH FIRE, TIE YOUR HAIR SO THAT IT IS AWAY FROM YOUR FACE.

7. WHEN WORKING WITH FIRE, WORK WITH ONE OR MORE PARTNERS.

8. WHEN WORKING WITH FIRE, FOLLOW ALL DIRECTIONS CAREFULLY.

Name________________________

Date_________________________

DASH

STUDENT PAGE 4.6.4B FIRE SAFETY

1. List the things that should be done for a person who has been burned.

2. What must we have to start a fire?

3. List ways we can put out a fire. For each way listed tell what is being controlled—temperature, air, or fuel.

DASH

Name____________________________

Date_____________________________

STUDENT PAGE 4.6.5A WAYS TO START A FIRE

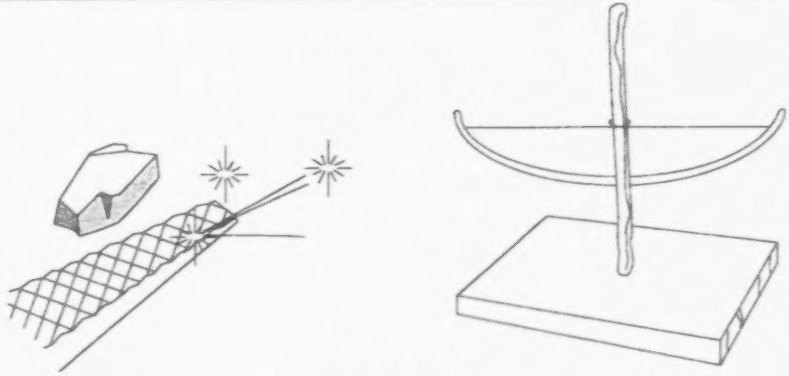
Fire is one of the most useful natural processes we humans have learned to control. It is also one of the most dangerous. A controlled fire can cook our food, heat our homes, fire pottery, and change ore into streams of pure metal. An uncontrolled fire can burn down homes, forests, entire cities, and it can burn and kill us.

Because we humans have learned how to control fire, it can be handled quite safely. However, we must always be sure we are safety conscious when we work with it. To help ensure safety, a safety monitor will be appointed in each working group.

We now need to find out how we can start a fire. Four ways are shown in Figure SP 4.6.5A:

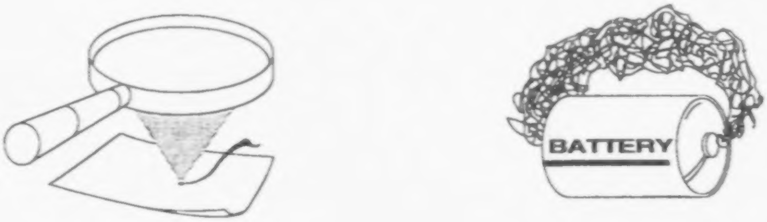
- Using flint and steel. Here a shower of sparks is produced that will start tinder burning. Blowing gently on the glowing tinder will produce a visible flame.
- Using a bow and fire drill. The drill produces heat at the fire hole in the base. Tinder touching the base will start to smolder and visible fire will burst out when it is gently blown on.
- Using a hand lens. A hand lens can focus light rays of the sun on tinder, heating it to its smoldering point.
- Using steel wool and a battery. The steel wool connects the poles of a dry cell. Electricity passing through the steel wool heats it to glowing. The hot wool can then be touched to tinder which will burn. A way has to be found to hold the steel wool to the poles so that the hot wool does not touch your fingers.

Name ____________________



Using a flint and steel

Using a bow and fire drilll



Using a hand lens

Using steel wool and a battery

Figure SP 4.6.5A Ways of starting a fire

DASH

Name________________________

Date_________________________

STUDENT PAGE 4.6.5B MAKING A FIRE

Describe how fires were started in your class investigations.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.6.6 FIRE OBSERVATIONS

1. List your questions, your predicted answers, and what your research showed about fire.

QUESTIONS	PREDICTIONS	FINDINGS

2. Describe a fire in terms of its temperature. Tell where it is hottest and coldest.

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Name ____________________

3. **Describe the kinds of things that burn.**

4. **Describe how the air moves around a fire.**

Name________________________

Date________________________

DASH

STUDENT PAGE 4.6.7 SMOKE AND THE LUNGS

1. Draw your simulated lung and label the trachea, chest, lung, and diaphragm.

2. Describe how you transferred exhaled air to the bottles of water.

Name ______________________

3. Compare the results of your tests on cigarette smoke and on air exhaled normally from the lungs.

Name______________________________

Date_______________________________

DASH

STUDENT PAGE 4.6.8 ALCOHOL, TOBACCO, AND DRUGS

1. **Summarize the medical, social, psychological, and economic problems involved with alcohol, tobacco, and nontherapeutic drugs.**

Name ______________________

2. **Summarize the problems on the international, national, and local levels and tell what is being done about them.**

DASH

GRADE FOUR
CLUSTER 7

Wayfinding and Transportation

4.7.1 Boat Design
4.7.2 Wind and Sails

ACTIVITY 4.7.1 BOAT DESIGN

OBJECTIVES

The students
- Review resisting forces.
- Design a streamlined boat hull.
- Use stone tools to make boat hulls to specification.
- Invent ways to test the effectiveness of streamlining.
- Test the streamlining of their boat hulls.

BACKGROUND

This activity follows Activity 4.8.2 FRICTION, 4.8.3 STREAMLINING, and 4.10.8 MAKING TOOLS FROM ROCK. BOAT DESIGN combines the study of streamlining and frictional resistance with the study of aboriginal technologies. In this activity the students use stone tools to shape the hulls of boats to get the least possible resistance in traveling through water. In Activity 4.7.2 WIND AND SAILS they fit their hulls with sails and race them.

One of the fascinating features of aboriginal boats of continental America and the Pacific is their streamlining. Most remarkably, their early boats were shaped with stone tools. The students should make stone tools in Activity 4.10.8 MAKING TOOLS FROM ROCK with the construction of boats in mind.

See Figure 4.7.1 for a device that can be used to test the streamlining of hulls. The students will need to invent a way to secure the rubber band on the hull.

STUDENT ROLES

Marine architect
Physicist

MATERIALS

String
Styrofoam or soft wood (white pine, balsa) blocks
  5 cm x 10 cm x 5 cm (2 in x 4 in x 2 in)
Rough stones for shaping hulls
Stone-cutting tools
Large rubber bands for boat catapult
Modeling or florist's clay for weighting and streamlining hulls
Aquarium to test boats
Grid paper for determining the surface area of decks
Watch
Student Page 4.7.1 BOAT DESIGN

PRODUCTS

Tested boat hulls
Completed Student Pages

PROCEDURES

1. **Have the students work in groups to make the most streamlined boat hulls they can from Styrofoam or soft wood. Tell them that after testing the hulls for streamlining they will mount sails on the hulls and race the boats.**

   A hull should have the following specifications:
   - Its deck surface should be at least 30 cm^2. (Discuss how to use grid paper to measure area.)
   - Its length must be 10 cm.
   - Its width at the broadest point should be 5 cm.
   - Its depth at the greatest point should be at least 5 cm.
   - When it sits in the water, no more than 1 cm of the hull should be above water. (Discuss how to get the wood or Styrofoam to sink to the 1-cm level. Entertain such ideas as weighting the hull.)

2. **Have the students draw their designs and shape their hulls.**

3. **Have the students invent a way to test their designs to determine which hulls are the most streamlined.**

4. **Have the students test all designs using a common system to determine their streamlining.**

5. **Have the students record their designs on Student Page 4.7.1 BOAT DESIGN.**

6. **Summarize the activity.**

   Ask such questions as
   - How did you determine which boat was most streamlined?
   - What is your working definition of "streamlined"?
   - How is the streamlining of boat hulls similar to streamlining the cardboard to reduce wind resistance in Activity 4.8.3 STREAMLINING?
   - How does friction seem to operate in water? (Get at the observation that it seems to slow the boat more than air.)
   - What kinds of tools did you use to shape your boat?
   - Which ones worked the best? Why?
   - What advantages do stone tools have over commercial tools. (Get at the idea that stone is easy to find and work with.)
   - What advantage would metal tools have over stone tools? (They don't break or wear out as quickly.)

EXTENSIONS

Have the students
- Develop a bulletin board on boat design.
- List situations in which friction seems to help us.
- List situations in which friction seems to hinder us.
- Make a bulletin board display of stone tools.

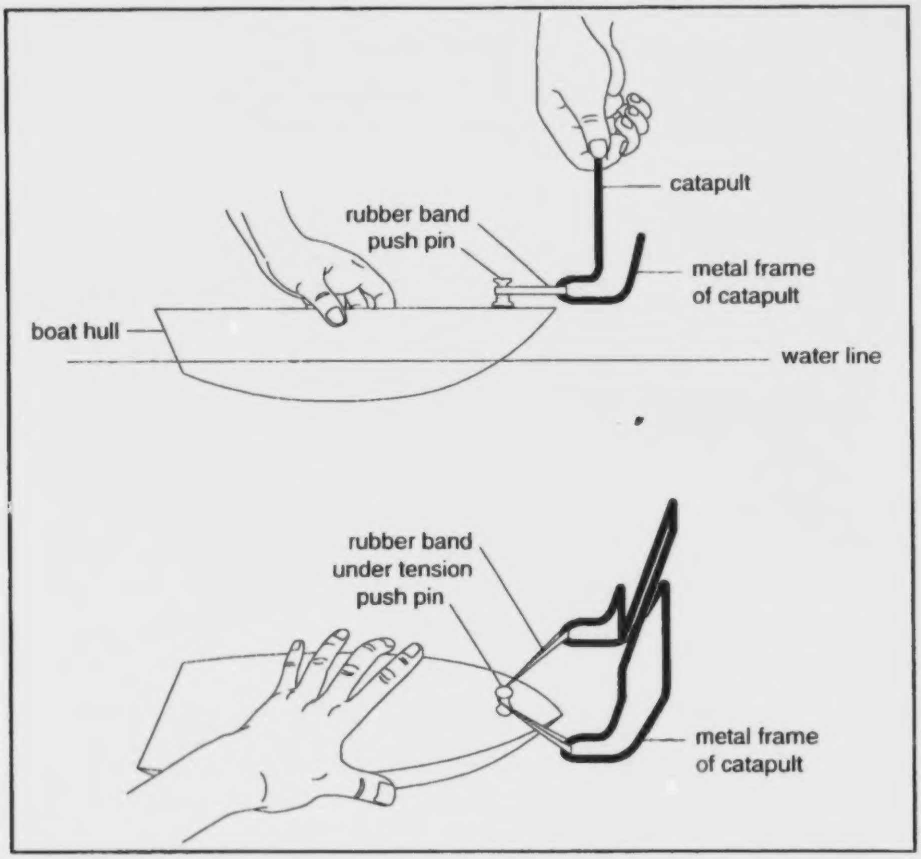
catapult
rubber band
push pin
metal frame
of catapult
boat hull
water line
rubber band
under tension
push pin
metal frame
of catapult

Figure 4.7.1 Top and side view of a boat catapult for testing a boat's streamlining

DASH

Name________________________

Date_________________________

STUDENT PAGE 4.7.1 BOAT DESIGN

1. Draw the top, front, back and side of your boat design.

2. How long did it take to shape your hull? __________

3. How did you determine the streamlining of your boat hull?

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4. What were the special characteristics of the fastest streamlined boat?

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ACTIVITY 4.7.2 WIND AND SAILS

OBJECTIVES

The students
- Add sails to their boat hulls.
- Test their boats by racing them.
- Modify their boats after testing them.
- Compare their boats with full-scale racing boats.

BACKGROUND

This is the second activity in the boat construction, testing, and sailing series. In this activity the students fit the boat hull they made in Activity 4.7.1 BOAT DESIGN with a sail to test it in a sailing competition.

This part of the activity not only requires that the students understand how to use the wind but also how to keep a boat traveling in a straight line. Steering may involve construction of a rudder, a keel, or other device. Sails can be made of paper, plastic, or Styrofoam cups secured to the deck of the boat.

A sailing lake can be built on the classroom floor or on a large desk by using plastic sheeting laid in a frame of 2 x 4 boards or other rigid objects to make sides. The lake should be at least 1-1/3 meters (4 ft) long and 2/3 meter (2 ft) broad. The depth of the water need be no greater than that of the deepest-reaching keel. Wind can be simulated by using a large fan. See Figure 4.7.2.

STUDENT ROLES

Yachter
Nautical engineer

MATERIALS

8-oz Styrofoam, paper, or plastic cups
Scissors
Push pins
Plastic sheeting for lake
2 x 4 boards for the sides of the lake
Large fan

Materials for sails as requested by designers
Modeling clay
Student Page 4.7.2 WIND AND SAILS

PRODUCTS

Boats
Lake
Completed Student Pages

PROCEDURE

1. **Tell the students that their boat hulls are going to be raced and that they will need sails. Help them standardize specifications for the sails.**

   Specifications might include the following:
   - All sails will be made out of cups, plastic, paper, or whatever.
   - All sails will be secured to the deck using push pins, tape, and so forth.
   - The size and shape of the sails are to be determined by the boat builders.

2. **Have the students make the sails for their boats.**

3. **Have the students test and modify their boats and sails by adding such items as keels and rudders.**

4. **Have the students set up a Yachting Board to decide all issues in the competition. Have the Yachting Board present a set of racing rules for consideration by the participants.**

5. **Describe the lake the students are to build. Work out its dimensions with the Yachting Board.**

6. **Have the Yachting Board carry out the race according to the rules agreed upon.**

7. **Summarize the activity.**

   Ask such questions as
   - What were the problems you had in preparing your boat for racing?

- What did you do to correct the problems?
- What made the fastest boat the fastest?
- What had to be done to keep the boat sailing on a straight path?
- How important was streamlining in winning the race? (Often problems with steering and sails will slow an otherwise fast hull.)
- How are our boats like those used in river, lake, and ocean racing?
- What things did you have to contend with that full-sized boats don't? (Get at such things as there is no one to steer the boat, sails cannot be adjusted well enough, designs are unproved, and so forth.)

EXTENSIONS

Have the students

- Collect pictures and articles about boat racing and relate them to their boats.
- Research how aboriginal boats were steered and kept from capsizing.

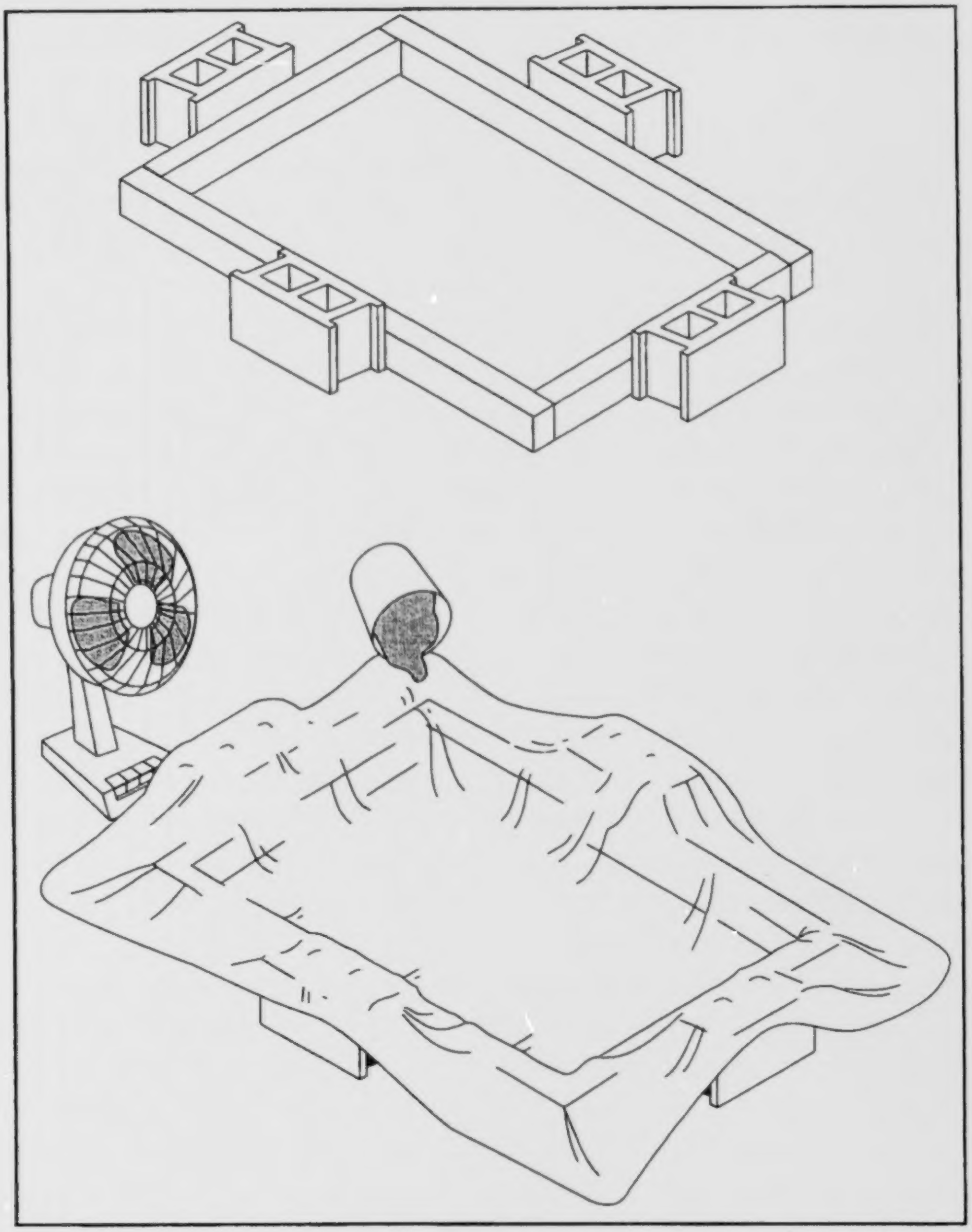

Figure 4.7.2 Class lake made of a board-block frame and plastic sheeting. Wind is produced by a fan.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.7.2 WIND AND SAILS

1. Draw a side, front, and top view of your boat.

2. List the problems you had in preparing your boat for racing and how you overcame them.

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777

DASH

Name________________________

Date________________________

STUDENT PAGE 4.7.1 BOAT DESIGN

1. Draw the top, front, back and side of your boat design.

2. How long did it take to shape your hull? __________

3. How did you determine the streamlining of your boat hull?

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4. What were the special characteristics of the fastest streamlined boat?

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DASH

Name________________________

Date________________________

STUDENT PAGE 4.7.2 WIND AND SAILS

1. Draw a side, front, and top view of your boat.

2. List the problems you had in preparing your boat for racing and how you overcame them.

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GRADE FOUR
CLUSTER 8

Energy and Communication

4.8.1 Push-Pull Measuring Tool
4.8.2 Friction
4.8.3 Streamlining
4.8.4 Pressure, Sharp Edges, and Points
4.8.5 Energy of Falling Objects
4.8.6 Circles and Speed

ACTIVITY 4.8.1 PUSH-PULL MEASURING TOOL

OBJECTIVES

The students
- Review the ways an object can be moved.
- Introduce "force" as a term describing both pushes and pulls.
- Make a tool to measure both pushes and pulls.
- Explore equal and unequal opposing forces.

BACKGROUND

In this activity the students continue to work at basic physics concepts. The activity should come after Activities 4.6.1 GROWTH CHART AND AREA MEASUREMENT, 4.10.1 LINEAR MEASUREMENT, 4.10.2 VOLUME MEASUREMENTS, and 4.10.3 MASS MEASUREMENT. It should be followed by 4.8.2 FRICTION.

In PUSH-PULL MEASURING TOOL the students are introduced to the concept of force. Force is found to be any push or pull. The students then make a tool to measure the relative strength of pushes and pulls (forces). For this work the scale of the push-pull measuring tool is marked in units of pull or force produced by measured amounts of water. The use of the pull of a milliliter of water as a measure of force is conceptually transparent and adequate for study at this level. It is not necessary to make a distinction between force and mass at this time.

Pushes and Pulls

In the practical world where we move such objects as refrigerators and furniture, there is an apparent difference in the amount of force needed to push things and the amount needed to pull them. Because we normally push with our legs using relatively strong muscles and pull with our arms using relatively weak muscles, we get the impression that it takes more force to pull than to push the same object. However, when forces are measured, pushes or pulls that move the same object at the same speed are found to be equal.

Before the students invent their own push-pull measuring tool, make a prototype and demonstrate how to use it. See Figures 4.8.1(1) and 4.8.1(2).

STUDENT ROLE

Physicist

MATERIALS

Coat hangers
Rubber bands
Small paper clips
I0-g measuring container (to hold 10 g of water)
3 x 5 file cards
Student Page 4.8.1 FORCE

PRODUCTS

Completed Student Pages
Push-pull measuring tools

PROCEDURES

1. **Develop a concept map of ways that objects can be moved and have the students separate them into categories: objects that can be moved by pushes and pulls, by heating, by chemical processes (explosions, growth), and by other means.**

2. **Introduce the technical term "force" to describe both pushes and pulls.**

   Ask such questions as
   - What is a push?
   - Who can demonstrate a push?
   - Who can demonstrate a different kind of push? Another kind? Another?
   - What is a pull?
   - Who can demonstrate a pull?
   - Who can demonstrate a different kind of pull? Another kind, another, and so forth.
   - Does anyone know a word that is used for both pushes and pulls? (Introduce the term "force," which is defined as a push or pull.)

3. **Introduce a prototype push-pull measuring tool.**

Show the students your push-pull measuring tool and discuss what it is supposed to do.

Ask such questions as
- How can we use this to measure a pull?
- Who can show us?
- How does it work?
- How can we use this to measure a push?
- Who can show us?
- How does it work?

4. **Have the students work in groups to make push-pull measuring tools and make a scale to measure pushes and pulls.**

Have them
- Use water in 10-mL units in a cup to standardize the scale. (The force measured is one produced by the pull of 1 mL of water.)
- Make a scale running in opposite directions to register pushes and pulls.

5. **Present Problem A: Can you standardize your scale with another group so that both groups measure the same amount of force when pulling?**

Have the students explore ways to solve the problem and then have them share and review their solutions. (The push-pull measuring tools can be arranged to pull on each other.)

6. **Present Problem B: Can you standardize your scale with another group so that both groups measure the same amount of force when pushing?**

Have the students explore ways to solve the problem and then have them share and review their solutions.(The push-pull measuring tools can be arranged to push on each other.)

7. **Present Problem C: How does the push scale relate to the pull scale?**

   Have the students explore ways to solve the problem and then have them share and review their solutions. (Work to the observation that the push and pulling forces are the same or almost the same.)

8. **Present Problem D: When two students grasping hands pull against each other without moving, how much force is each applying?**

   Choose two students to act out the problem.

   Ask such questions as
   - Are they applying the same or different amounts of force?
   - How could you find out?

9. **Present Problem E: What happens when one student grasping hands pulls harder than the other?**

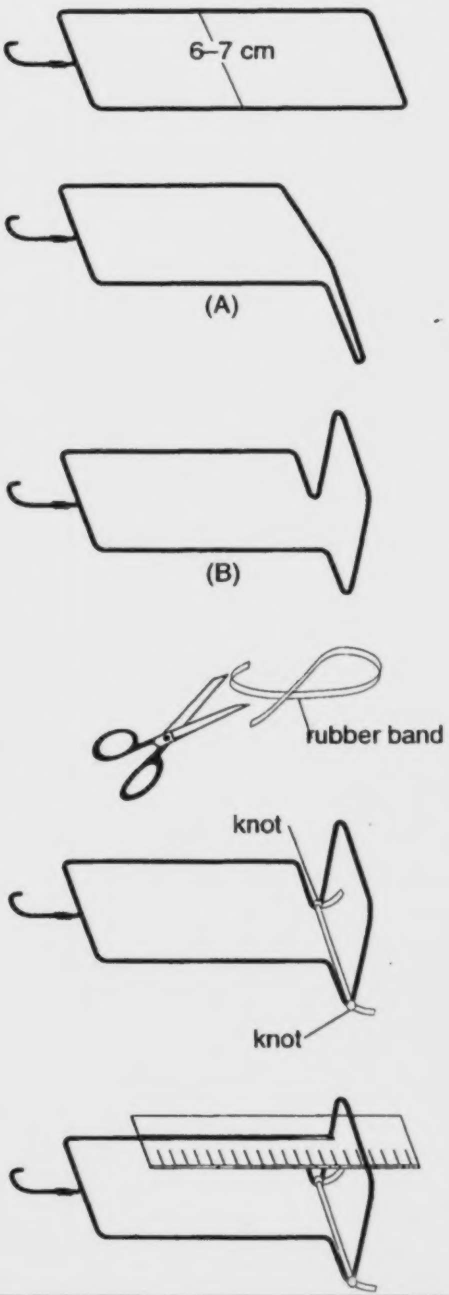
   Have two students act out the problem.

   Ask such questions as
   - What happened? (Get agreement that there is movement.)

10. **Have the students summarize the activity using Student Page 4.8.1 FORCE.**

EXTENSIONS

Have the students
- List additional examples of equal forces pushing and pulling against each other, for example, two teams in a tug of war when there is no movement and a wall's pushing back when we lean on it.
- List additional examples of unequal forces pushing and pulling against each other-pushing a toy car, throwing a ball, and so forth.



STEP 1
Bend a coat hanger in
the form of a rectangle

STEP 2 (A) (B)
Make a notch to hold
a rubber band

STEP 3
Cut a rubber band

STEP 4
Tie the rubber band
to the wire frame

STEP 5
Attach a scale

Figure 4.8.1(1) Making a push-pull measuring tool

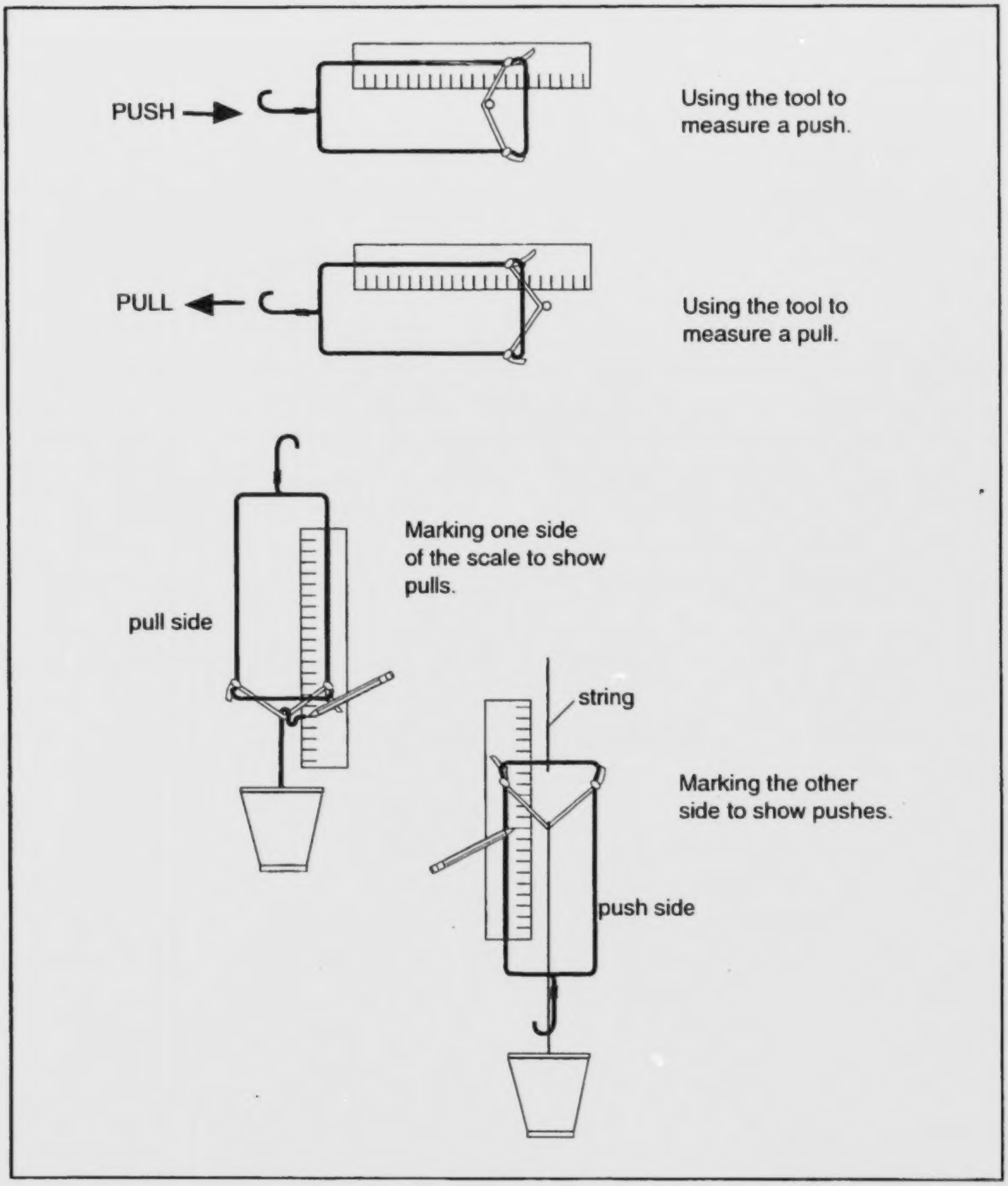

PUSH
Using the tool to measure a push.
PULL
Using the tool to measure a pull.
Marking one side of the scale to show pulls.
pull side
string
Marking the other side to show pushes.
push side

Figure 4.8.1(2) Using the push-pull measuring tool

DASH

Name________________________

Date________________________

STUDENT PAGE 4.8.1 FORCE

1. List ways objects can be made to move.

2. Give your working definition of "force."

3. Draw your push-pull measuring tool.

Name ______________________________

4. Describe how your push-pull measuring tool works.

5. Describe how you standardized your push pull-measuring tool.

6. Describe what happens when two equal pushes (forces) work against each other.

7. What happens when two unequal forces work against each other?

ACTIVITY 4.8.2 FRICTION

OBJECTIVES

The students
- Investigate the amount of force it takes to push and pull an object sliding on a surface.
- Investigate how it is possible for the same object to require different amounts of force to move, depending on the surface areas in contact.
- Investigate how objects with the same surface require different amounts of force when their weights are different.
- Create a working definition of friction.
- Summarize the ways friction can be increased and decreased.

BACKGROUND

This activity comes after Activity 4.8.1 PUSH-PULL MEASURING TOOL. In 4.8.2 FRICTION the students explore how the amount of surface and weight create a resistance to movement called **friction**.

A range of objects can be pulled. Tuna cans are convenient because their height is low and they have a fair capacity to hold objects and liquids. Run a file over the bottom edge of the cans to be sure there are no burrs. Wood blocks can also be used in this activity. Blocks of the same dimensions may require different amounts of force to move them. Raised wood grain will tend to reduce the frictional surface. Blocks with a raised grain can be used to create an anomaly after blocks with a smooth surface are tested.

NOTE: Use of wood blocks not specially made for experimentation and student-made push-pull measuring devices gives rough data that will be refined over time.

STUDENT ROLE

Physicist

MATERIALS

File
Tuna cans
String

Wood blocks
Weights (sand)
Balance and counter balances (counterweights)
Graduate to measure sand
Push-pull measuring tool
Thumbtacks
Student Page 4.8.2 FRICTION

PRODUCTS

Push-pull measuring tools
Completed Student Pages

PROCEDURES

1. **Make a concept map of the term "force."**

   Help the students include
   - Push.
   - Pull.
   - Weight.
   - Scale.
   - Gravity.

2. **Present Problem A: How can we use our push-pull tool to measure the amount of force it takes to pull a tin can or block of wood?**

   Have the students
   - Explore the problem.
   - Report their solutions.

3. **Present Problem B: How can we use our push-pull to measure the amount of force it takes to push a tin can or a block of wood?**

   Have the students
   - Explore the problem.
   - Report their solutions.

4. **Present Problem C: How does the amount of force needed to pull the can or block compare with the amount of force needed to push it?**

Have the students
- Explore the problem.
- Report their solutions.

(The experimental data will be messy. Some data will show slightly more push than pull, some slightly more pull than push, and some about the same amount of push and pull. Work to the idea that on looking at all the data it seems to take about the same amount of force to push or pull an object.)

5. **Present Problem G: Can you find a way to reduce the amount of force needed to move the can or block?**

   Have the students
   - Explore the problem. (Support such ideas as putting thumbtacks on the bottom of the block, polishing the bottom of the can, and running the can or block over glass or metal foil.)
   - Report their solutions.

6. **Present Problem H: Can you find a way to increase the amount of force needed to move the can or block?**

   Have the students
   - Explore the problem. (Support such ideas as Increasing the weight or increasing the roughness of the surface on which it slides will increase the amount of force needed.)
   - Report their solutions.

7. **Have the students develop their own working definition of friction with examples.**

8. **Have the students use Student Page 4.8.2 to summarize what they have learned about increasing and decreasing friction.**

EXTENSION

- Have the students make a list of places where they find friction operating.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.8.2 FRICTION

1. Compare the amount of force used to push and pull the same object over the same surface.

2. Explain how you can reduce the amount of force needed to pull an object across a surface?

3. Describe what happens to the force needed to pull an object as its weight increases.

4. Give your working definition of "friction."

ACTIVITY 4.8.3 STREAMLINING

OBJECTIVES

The students
- Review resisting forces.
- Solve problems about air and resistance to motion.
- Solve problems about water and resistance to motion.
- Develop working definitions for water resistance, air resistance, and streamlining.

BACKGROUND

This activity builds on Activities 4.8.1 PUSH-PULL MEASURING TOOL and 4.8.2 FRICTION and introduces wind and water as producers of resistance to movement. The students first work in groups and use their push-pull tool to solve a series of problems involving the measurement of the resistance of air and water to moving objects. Next teams of students hold sheets of cardboard and run races. They then invent ways to streamline the cardboard so that they can run faster. Normally a wing-like structure will provide the least friction.

The cardboard race involves air resistance or friction. Because this is a team effort to test streamlining, the teams should be about equal in ability to run fast. Every team should have some slow students.

STUDENT ROLES

Aerospace engineer
Marine architect
Physicist

MATERIALS

Large pieces of light cardboard about (1 m x 2 m)
String
Styrofoam blocks
Rough stones for shaping Styrofoam
Aquarium
Push-pull measuring tool from Activity 4.8.2 FRICTION
Student Page 4.8.3 STREAMLINING

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Review the idea of resisting forces.**

   Have the students suggest a list of things that cause resistance to motion. Help them include such things as
   - Surfaces that touch each other (friction).
   - Wind pushing against something.
   - A spring holding something back.
   - Water pushing against a boat.

2. **Present Problem A: Can you use a piece of heavy paper and some string to demonstrate with your push-pull measuring tool that air can offer resistance to movement?**

   Have the students
   - Explore the problem.
   - Review their solutions in their work group. (A paper parachute might be made to show how air creates a resistance when attached to a moving push-pull measuring tool.)

3. **Present Problem B: Can you take that same piece of paper that you used in Problem A and reduce its resistance to air?**

   Have the students
   - Explore the problem.
   - Review their solutions in their work group.

   Ask such questions as
   - How could we get maximum resistance to motion using the paper?
   - How could we get the least amount of resistance to motion with the paper? (Get at the idea of streamlining.)
   - What seems to happen to resistance as the speed of the object increases? (Get agreement that it seems to increase.)

4. **Present Problem C: Can you use a piece of Styrofoam and a string to demonstrate that water can offer resistance to motion?**

Have the students
- Explore the problem.
- Review their solutions in their work group. (Get agreement that the blunt piece seems to give the greatest resistance.)

5. **Present Problem D: Can you use the same piece of Styrofoam that you used in Problem C and reduce the resistance to force?**

Have the students
- Explore the problem.
- Review their solutions in their work group. (They can use stones to streamline a piece of Styrofoam.)

Ask such questions as
- How could we get maximum resistance to motion using the Styrofoam?
- How could we get the least amount of resistance to motion in water with the Styrofoam? (Get at the idea that objects shaped to allow water to pass beneath them seem to have the least resistance.)
- What happens to resistance as the speed of the object increases? (Get agreement that it increases.)

6. **Have the students run cardboard races.**

Have them run races with large pieces of corrugated cardboard of the same size held by all members of teams of 3 to 5 people. The object is to run the fastest.

- GAME 1. A race with the cardboard held in front of the runners.
- GAME 2. A race with the cardboard held overhead.
- GAME 3. A free-form race with the cardboard held any way the students wish.

Ask such questions as
- How did holding the cardboard affect your speed?
- What did you have to do to the cardboard to increase your speed?

- How does this investigation relate to the shape of a car or an airplane? (Work to agreement that high-speed vehicles work best when streamlined.)

7. **Summarize the investigation using the Student Page 4.8.3 STREAMLINING.**

Introduce the term "streamlining."

Have the students
- Develop a working definition for **streamlining**.
- Develop a working definition for **water resistance**.
- Develop a working definition for **air resistance**.
- Compare their definitions for **friction** and **water** and **air resistance**. (Work for a generalization that friction refers to a resistance to movement in, through, or over any medium—solid, liquid, or gaseous.)

EXTENSION

- Have the students list situations in which streamlining is important. and explain why.

Name__________________________

Date___________________________

DASH

STUDENT PAGE 4.8.3 STREAMLINING

1. Explain what we mean by "resistance to movement."

2. Describe how you made a piece of paper have more or less resistance to movement through air.

3. Describe how you made a piece of Styrofoam have more or less resistance to movement through water.

Name ____________________________

4. Describe the entries in the cardboard race.

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5. Describe the winning team and tell why it won.

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6. Give your working definition of "streamlining."

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ACTIVITY 4.8.4 PRESSURE, SHARP EDGES, AND POINTS

OBJECTIVES

The students
- Explore ways to get a wooden peg to penetrate corrugated cardboard.
- Compare the cutting qualities of a sharp stone blade and a dull blade of the same material

BACKGROUND

This activity continues the study of stone implements. It should follow Activity 4.10.7 ROCKS AND SHARP EDGES. As the students work through the activity they observe that cutting is determined by **pressure**—the amount of **force** on a given area. The same amount of force pushing on a very small area results in great pressure compared to the smaller amount of pressure produced when the same weight is distributed over a larger area. Thus a sharp pin pushed by the finger sinks deeper into wood than a nail, a sharp blade of a knife deeper than a dull blade.

STUDENT ROLES

Maker of stone tools
Physicist

MATERIALS

Flint, obsidian, glass (or dull and sharp knives or blades)
Wood pegs (pine or other soft wood about 1 x 1 x 10 in with grain running lengthwise)
Rasps or coarse-grained rock to sharpen pegs
Brick
Corrugated cardboard sheets (about 10 cm x 10 cm)
Push pins
Twelve- or sixteen-penny nails
Student Page 4.8.4 POINTS AND SHARP EDGES

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Introduce the problem of how can we get a wooden peg to penetrate the greatest number of layers of dry corrugated cardboard after placing a brick on top of it? (No hammering allowed.)**

    - Give each group of students a peg, a brick, and a rough rock or a rasp and a stack of cardboard sheets.
    - Have each group try to get the pegs through as many sheets of cardboard as possible by laying the brick on top of the peg.
    - Have each group demonstrate its system.

2. **Compare a push pin and a nail with a larger diameter to see which will penetrate deeper into wood when a brick is placed on it.**

    Ask such questions as
    - Which of these two will push deeper into wood when we put the same amount of weight on top of it? Why?
    - Can you demonstrate your answer?
    - How is this similar to our peg problem?
    - Would you be willing to have a push pin with a brick on it placed on your hand? Why?
    - Would you be willing to have the brick put directly on your hand? Why?
    - What is the difference between having the brick alone on your hand and having the weight of the brick pushing on the pin on your hand? (Work to the idea that in the first case the weight of the brick is spread out while in the second it is concentrated on a point.)
    - What would you do to make a spear penetrate deeply into the side of a bear? (Work to the idea of thrusting with great force into a soft area of the body and having a very sharp point on the spear.)

3. **Return to the wooden peg problem and have students again try to get maximum penetration.**

    Help the students
    - Sharpen the peg.
    - Narrow the peg.
    - Demonstrate how they got maximum penetration.

4. **Have the students compare cutting with sharp flakes of flint, obsidian, or glass and cutting with a dull blade of the same material. (Dull and sharp knives can be substituted.)**

Have them
- Make several flakes from flint, obsidian, or glass.
- Select the sharpest flake and the dullest flake.
- Further dull the dullest flake by rubbing it over a rock of equal or greater hardness.
- With light pressure draw the sharp flake across the edge of a pine block. Note how deeply the blade cuts.
- Draw the dull flake across the edge of the pine block, making a cut as deep as that produced by the sharp flake.
- Note what has to done to get the two flakes to cut equal depths. (Get agreement that greater force [or push] is required with the dull flake than the sharp one.)

5. **Summarize the activity using Student Page 4.8.4 POINTS AND SHARP EDGES.**

Ask such questions as
- What must we do to get a dull knife to cut as deeply as a sharp knife? (Get at the idea that we have to push harder on the dull knife.)
- Does this suggest a way that we could get a dull peg to penetrate cardboard?
- What would we have to do? (Work to the idea that we could put more weight on it.)
- Can you demonstrate this?
- If you were making an arrowhead, what characteristics would you want it to have? (Lead discussion to include sharpness, pointedness, hardness, and so forth.)

EXTENSIONS

Have the students
- Keep a list of devices that have points to penetrate surfaces. (Pins, needles, picks, hooks, and so forth.)
- Keep a list of blades used to cut things. (Axes, shovels, hoes, sickles, and so forth.)

DASH

Name________________________

Date________________________

STUDENT PAGE 4.8.4 POINTS AND SHARP EDGES

1. Describe how a peg can be made to penetrate deeply into cardboard.

2. What does one have to do to get a sharp and a dull edge to cut to equal depths?

3. How is a peg like a blade in its penetrating ability?

ACTIVITY 4.8.5 ENERGY OF FALLING OBJECTS

OBJECTIVES

The students
- Develop a concept map of the term "energy."
- Invent a way to compare the energy of falling objects.
- Discover that height and mass determine the energy in falling objects.

BACKGROUND

This activity should follow Activity 4.8.4 PRESSURE, SHARP EDGES, AND POINTS. In ENERGY OF FALLING OBJECTS we return to the definition of energy used since kindergarten. **Energy** is anything that can make an object glow, grow, or go. Focus here is on energy of motion. The students are to invent ways of comparing the energy of motion produced by falling objects.

Three forms of energy have been considered to date.
- Radiant energy as found in heat and light. (Energy that makes things **glow**.)
- Chemical energy found in living and non-living things increase in size. (Energy that makes things **grow** or increase in size.)
- Mechanical energy or energy of motion as found in moving things (Energy that makes things **go**.)

In this activity the students invent different ways to compare the energy of motion. Several suggestions are shown in Figure 4.8.5. Control the invention by what you put in the Inventor's Box. Small stones of different sizes or balls of the same material can be used as falling objects.

Mechanical Energy

The mechanical energy, or energy of motion, of an object is determined by the mass of an object and its speed. When an object such as a stone falls, it gains speed as it gets closer and closer to the floor or ground. The higher it was when it was dropped, the greater its speed when it hits and the greater the energy it delivers to whatever it hits. Examples are numerous. Massive stones falling off a truck can mash cars while small pebbles dropping off the same truck will simply bounce away. However, a fast-moving pebble can break a windshield.

Generalizations

Two generalizations flow out of this activity. The first is that the faster a falling object moves, the greater the energy it has. The second is that of two objects falling at the same speed the one with the greater mass will have the greater energy. Therefore, we can say that the energy of motion is determined by the mass and speed of an object.

Real and Ideal Worlds

There are some subtleties in this observation that need to be recognized. In the ideal world of a vacuum a sheet of paper and a ball made of the same of amount paper will fall to the ground at the same speed when dropped from the same height. In our real world students will find that the crumpled sheet of paper will fall faster than an uncrumpled sheet. Air resistance makes the difference. In fact, in air objects dropped from great height reach a certain speed beyond which they can go no faster. This is called **terminal velocity.** These exceptions aside, the generalization about mass and speed to produce increased energy will flow out of this inquiry.

STUDENT ROLE

Physicist

MATERIALS

Marbles (different sizes)
Base ball
Tennis ball
Rulers
Tuna cans
Large cans of sand
Platform spring scales
Stones
Styrofoam
Wood blocks
Coat hanger
Pliers
Modeling clay
Pencil
Energy-measuring device
Balance from Activity 4.10.3 MASS MEASURE
Student Page 4.8.5 FALLING OBJECTS

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Develop a concept map of the term "energy."**

   Include such ideas as
   - Energy is in anything that can make things **glow**.
     - Heat
     - Light
   - Energy is in anything that can make things **grow**.
     - Build
     - Fabricate
   - Energy is in anything that can make things **go.**
     - Move
     - Fall
     - Explode

2. **Explore things that can make other things "go" or move, giving them energy of motion.**

   Use a game format. Present an object and ask how it can be moved. Have each student add a new and different method of moving the object and identify the energy source. Include such things as
   - A block.
   - A car.
   - A house.
   - A mountain.

3. **Help the students establish that a falling object has energy of motion and can make other things move.**

   Use the same game format as in Procedure 2. Ask how they could show that a falling ball moves
   - Another ball.
   - A mound of sand.
   - A stick in the sand.
   - A teeter-totter.
   - A spring.

4. **Have the students invent a way to measure the energy of two falling stones of different mass. Have them drop the two stones from the same height.**

   Assist the invention with probing questions such as
   - If a tennis ball and a baseball of the same size were dropped from the same height, would they have the same energy?
   - Which will make something go or move more?
   - How can you measure the difference in movement? (Anything that will move on being hit will work—a spring, a pool of water, another ball, and so forth.)

5. **Have the students explore what seems to determines how much energy objects have when they fall from the same height.**

   Ask such questions as
   - Did the falling stones of different mass have the same energy when they fell from the same height? (Get agreement that the more massive stone had the greater energy. It made something else move more.)
   - Could you make falling stones of different mass have the same energy? How? (Get at the idea that the stones might move faster or slower.)
   - What seems to determine the energy in the fallen object? (Get agreement that mass and speed seem to be important.)

6. **Have the students explore what happens to the amount of energy from the same falling object when it is dropped from different heights.**

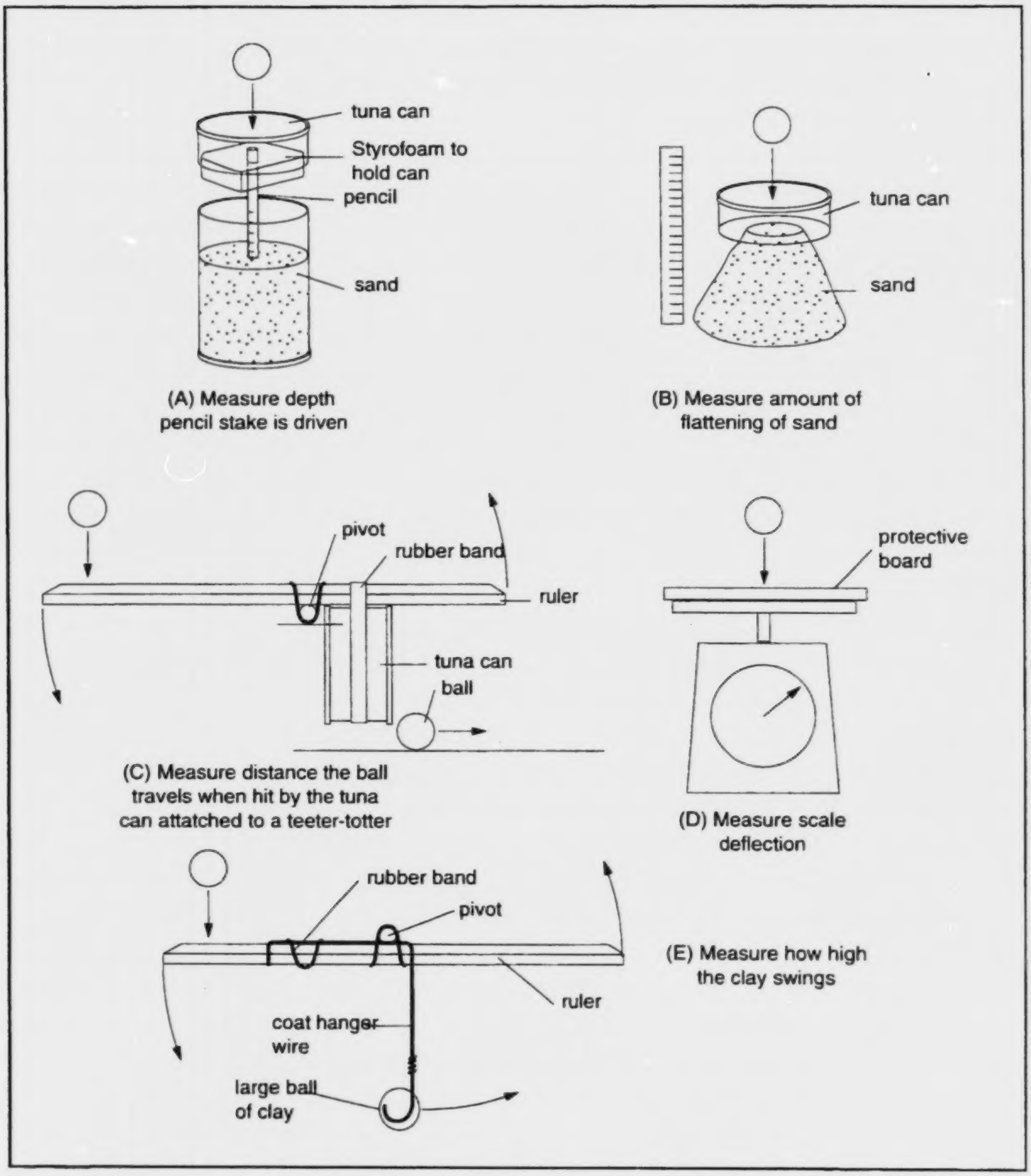
   Ask such questions as
   - What happens to the energy as we change height. (Get agreement that as we increase the height of the drop, the amount of energy in the object increases.)
   - What happens to the speed of the object as it is dropped from ever higher positions? (Work toward the idea that as its height increases, its speed increases.)

7. **Summarize the activity using the Student Page 4.8.5 FALLING OBJECTS.**

Ask such questions as
- What can we say about mass and the energy of moving or falling objects? (Get agreement that the greater the mass of similar objects moving at the same speed, the greater the energy.)
- What can we say about the effect of height and energy? (Get agreement that as we increase the height, we increase the energy.)
- What can we say about the speed of an object and its energy? (Get agreement the faster the object goes, the greater the energy.)
- How are height and speed of a falling object related? (Get agreement that the longer an object falls, the faster it travels.)

EXTENSIONS

Have the students
- Find an ideal personal throwing stone. What are the characteristics of such a stone? What can you do with this stone that you can't do with other stones?
- Research how ancient armies hurled large stones so that they had enough energy to smash fortress walls.


tuna can
Styrofoam to hold can
pencil
sand
tuna can
sand
pivot
rubber band
ruler
tuna can
ball
protective board
rubber band
pivot
ruler
coat hanger wire
large ball of clay

(A) Measure depth pencil stake is driven

(B) Measure amount of flattening of sand

(C) Measure distance the ball travels when hit by the tuna can attatched to a teeter-totter

(D) Measure scale deflection

(E) Measure how high the clay swings

Figure 4.8.5 Devices to measure the relative amount of energy of falling objects

Name________________________

Date________________________

STUDENT PAGE 4.8.5 FALLING OBJECTS

1. What is energy?

2. Describe how you measured the energy of falling objects.

3. What properties of falling objects determine the amount of energy they can transfer to other objects?

ACTIVITY 4.8.6 CIRCLES AND SPEED

OBJECTIVES

The students
- Are introduced to circular motion.
- Formulate and test hypotheses about speed and its relation to radius.
- Invent a sling.

BACKGROUND

This activity should follow Activity 4.8.5 ENERGY OF FALLING OBJECTS. In CIRCLES AND SPEED the students explore circular motion. This is done through analysis of a series of games.

In the first game the students throw a ball for distance using their forearms only. In the second game they use their entire arm to throw the same ball for distance. In the third game they play Crack-the-Whip.

Throwing Games

The data on ball throwing will be messy if different student performances are compared. It is better to have the students use their own throwing data for comparison. Generally longer-armed individual will have greater speed of delivery because of a longer arc through which the arm moves. However, this potential may not be realized for several reasons:
- For maximum distance the ball must be thrown upward at an angle of between 35 and 45 degrees. A shorter-armed individual throwing at 40 degrees may exceed the distance thrown by a longer-armed individual throwing straight ahead.
- Speed, or how fast the ball travels, is determined in part by the snap in the wrist as well as the distance and the time the arm travels through the throwing arc. Again a shorter-armed individual may have more snap and outthrow a longer-armed individual.

Crack-the-Whip Game

In the Crack-the-Whip game each person travels in a circle. The relative circumference of the circle or distance that each person must travel increases with the distance from the whipmaster. Each person travels through their circumference in the same period of time. The whipmaster at the center moves the most slowly. The person at the far end travels through the greatest cycle and goes the fastest.

Sling Game
Finally, the students make a sling. Have them enclose a tennis ball in a section of a hose and attach this to a strong piece of string about 1 meter long. When the device is whirled in a circle, the students have a sling. Here rather than releasing the ball they can release the ball and string together.

STUDENT ROLE

Physicist

MATERIALS

Meter-string can
Chalk
Tennis balls
Hose or sock for sling
String
Student Page 4.8.6 CIRCLES AND SPEED

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Introduce Games 1 and 2, Ball Throwing for Distance.**

   Have all the students work in small groups on the playground.

   GAME 1
   The players
   - Throw a ball three times using only their forearm.
   - Measure and record their personal longest distance thrown.

   GAME 2
   The players
   - Throw a ball three times using the entire arm.
   - Measure and record their personal longest distance thrown.

2. **Analyze the results of Games 1 and 2 to determine what seems to affect the distance each person can throw.**

   Ask such probing questions as
   - How many threw farthest with their forearms only? (Probably few.)
   - What was different in throwing with your whole arm and your forearm only? (Work toward the idea that the whole arm moves through a larger arc than the forearm in throwing the ball. The larger the arc, the farther the ball was thrown.)
   - What other factors seem to determine how far we can throw? (Work toward the idea of getting maximum speed and the best angle (35°–45°) to throw the ball.)

   After analysis have the students return to the field to improve their distance using whatever method they choose.

3. **Introduce Game 3, Crack-the-Whip, on a grassy area.**

   Have the students
   - Work in groups of 4–5.
   - Play Crack-the-Whip, giving each member a chance to play central whipmaster and positions 1, 2, 3, and 4.
   - Use their meter-string cans and measure the distance of each position from the whipmaster. Record the data.
   - Use their meter-string to draw a chalk circle of the path through which people in each position traveled.
   - Measure the circumference or distance traveled in each circle. Record the data.

4. **Analyze the results of Game 3 to determine the effect of distance from the center and speed.**

   Ask such questions as
   - Who traveled the fastest?
   - Who traveled the slowest?
   - Who traveled the farthest?
   - Who traveled the shortest distance?
   - What do we mean by “fastest”? (Work to the idea that the “fastest” means the greatest speed or who went the farthest in some period of time.)

5. **Bring together the results of Games 1, 2, and 3.**

   Ask such questions as
   - How does knowing about Game 3 help us understand how far we can throw a ball?
   - Does the length of our arms relate to the length of the whip? If so, how? (Get at the idea that the longer the arc, the faster the ball is moving. Most pitchers are tall and long armed.)
   - If we had balls of the same size and weight connected to strings and could swing those balls in a circle, would the balls on the longer or shorter strings travel farther? Why? (Have the students record their predictions and reasoning.)

6. **Demonstrate the making of a sling. Have the students test their predictions about balls on a string.**

7. **Summarize the activity using Student Page 4.8.6 CIRCLES AND SPEED.**

   Ask such questions as
   - What length of string gave you the greatest distance of flight of the ball?
   - With what length of string were the balls traveling the fastest when they were released?
   - About what angle of release seemed to give the greatest distance? (This will be 35°–45°.)
   - How would you throw a spear to get the greatest distance?
   - Could you invent a sling so that you would not lose the string and pouch each time you threw a ball?

EXTENSION

Have the students
- List devices that rotate slowly at their center but move very fast at their outer edge (merry-go-rounds, Ferris wheels, and other amusement park rides; bicycle wheels; wheels of all kinds; gears, and so forth).
- Research how slings were made and operated in times past.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.8.6 CIRCLES AND SPEED

1. Describe what you did to throw the ball the farthest.

2. Describe how you got different speeds along the Crack-the-Whip chain.

3. Describe how you got the greatest distance with a ball on a string.

Name______________________________

Date______________________________

STUDENT PAGE 4.8.1 FORCE

1. **List ways objects can be made to move.**

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2. **Give your working definition of "force."**

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3. **Draw your push-pull measuring tool.**

Name ______________________________

4. **Describe how your push-pull measuring tool works.**

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5. **Describe how you standardized your push pull-measuring tool.**

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6. **Describe what happens when two equal pushes (forces) work against each other.**

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7. **What happens when two unequal forces work against each other?**

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Name________________________

Date________________________

DASH

STUDENT PAGE 4.8.2 FRICTION

1. Compare the amount of force used to push and pull the same object over the same surface.

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2. Explain how you can reduce the amount of force needed to pull an object across a surface?

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3. Describe what happens to the force needed to pull an object as its weight increases.

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4. Give your working definition of "friction."

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Name_______________________

Date_______________________

DASH

STUDENT PAGE 4.8.3 STREAMLINING

1. Explain what we mean by "resistance to movement."

2. Describe how you made a piece of paper have more or less resistance to movement through air.

3. Describe how you made a piece of Styrofoam have more or less resistance to movement through water.

Name ______________________

4. Describe the entries in the cardboard race.

5. Describe the winning team and tell why it won.

6. Give your working definition of "streamlining."

Name____________________________

Date____________________________

DASH

STUDENT PAGE 4.8.4 POINTS AND SHARP EDGES

1. Describe how a peg can be made to penetrate deeply into cardboard.

2. What does one have to do to get a sharp and a dull edge to cut to equal depths?

3. How is a peg like a blade in its penetrating ability?

DASH

Name________________________

Date________________________

STUDENT PAGE 4.8.5 FALLING OBJECTS

1. What is energy?

2. Describe how you measured the energy of falling objects.

3. What properties of falling objects determine the amount of energy they can transfer to other objects?

Name________________________

Date________________________

DASH

STUDENT PAGE 4.8.6 CIRCLES AND SPEED

1. Describe what you did to throw the ball the farthest.

2. Describe how you got different speeds along the Crack-the-Whip chain.

3. Describe how you got the greatest distance with a ball on a string.

DASH

GRADE FOUR
CLUSTER 9

Conservation, Recycling, and Decomposition

4.9.1 Unearthing and Burial

4.9.2 Recycling Project

ACTIVITY 4.9.1 UNEARTHING AND BURIAL

OBJECTIVES

The students
- Locate their grade 3 burial site and predict the state of the materials.
- Dig up and inventory the burial contents. Observe and record the state of the materials.
- Give the unearthed materials additional protection as needed, add new materials for testing, and carry out a new burial.

BACKGROUND

This activity continues a series of burials and unearthings of biological and non-biological materials started in kindergarten. At the end of the third grade, DASH students bury materials that will be inventoried in the fall of grade 4 and then reburied for unearthing in grade 5. DASH students should have listed in their grade 3 Science Record Books the items they buried as well as a record of the location of the burial site.

In this activity the students unearth the buried materials and inspect them for signs of decomposition. After recording their observations, they should rebury all items. The students can invent ways to give additional protection to materials they want to continue to preserve. Again, the students should make a map of the burial site so they can find it later.

Unearthing Grade 3 Materials

You may wish to work with other DASH 4 classes to unearth all the grade 3 materials at the same time. The materials can be divided for additional treatment and then reburied.

If there are no other DASH 4 classes and there were several DASH 3 burials, you may wish to unearth them all. If there are no buried materials, carry out a new burial with some materials the students predict will decompose within four to six months and some they predict will not decompose in that length of time. Have the students bury the materials in plastic-mesh bags and keep a record of what they bury and where they bury it.

Items Buried

Items in long-term decomposition will probably include such things as bone, paper, plastic, cloth, wood, tin and aluminum cans, and iron and

STUDENT ROLE

Recycler

MATERIALS

Student Page 4.9.2 RECYCLING PROJECT

PRODUCTS

Recycled materials
Completed Student Pages

PROCEDURES

1. **Explain that the first graders have asked for help with their recycling project. Help the students organize to help the first graders.**

   Have the students
   - Invite the first graders to come in to talk about their project and what they need in the way of help.
   - Listen to what the first graders have to say and discuss what needs to be done.
   - Set up committees to organize the assistance.
   - Report ideas and come up with a master plan.
   - Get agreement with the first graders.

2. **Have the students carry out the recycling project.**

3. **Have the two classes plan and have a party to celebrate completion of the project.**

4. **Summarize the activity. Have the students record their feelings and ideas on Student Page 4.9.2 RECYCLING PROJECT.**

   Ask such questions as
   - How did you like helping the first graders?
   - What did you learn in working with first graders?
   - What did you learn about yourself in working with first graders?
   - How does it help to know how other people think and why they do things?

- Why do we recycle things once we use them? (Work to the idea of a need to conserving resources, particularly those that are not renewable such as metals, petroleum, and coal. Recycling such things as metals, plastic, synthetic rubber, and motor oil helps conserve the petroleum and coal from which they are made.)
- What happens to recycled materials once we deliver them to a recycling center? (Have the students recall that they are processed into materials for new manufacture.)

EXTENSION

- Have the students make a photo record of the recycling project to give the first graders.

DASH

Name____________________

Date____________________

STUDENT PAGE 4.9.1 UNEARTHING AND BURIAL

1. Using the grade 3 records, list what was buried and your predictions about decomposition. Record your observations of what you actually found.

ITEMS	PREDICTIONS	OBSERVATIONS

2. Record new ways you treated items to preserve them.

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Name ______________________

3. Draw a map of the new burial site.

4. List the things that were buried and your predictions of what will happen to them over the next burial period.

THINGS BURIED	PREDICTIONS

ACTIVITY 4.9.2 RECYCLING PROJECT

OBJECTIVES

The students
- Work with first graders on a recycling project.
- Identify the importance of working with people outside their circle.
- Recycle plastic or glass.

BACKGROUND

This activity is part of the ongoing cooperative program between DASH classes at different grade levels to recycle and conserve materials and energy. It is suggested that the first grade be the companion class for the fourth grade. Below is a suggested school cooperation scheme with classes paired according to recycling projects.

Companion Grades	Suggested Recyclables
Grade 6 and kindergarten	Paper
Grades 5 and 2	Aluminum cans
Grades 4 and 1	Glass and plastic

Several advantages can be gained from such cooperation, including
- Gaining insight into the physical and intellectual growth and development of younger children.
- Creating a healthy sense of family within the school.
- Reinforcing society's need to recycle and reuse new materials.

In this activity the students organize to work with first grade students on their recycling project. This will require
- Contacting a first grade colleague to set up class interaction.
- Communicating a need for help by the first grade class.
- Arranging a time for first grade students to come to the fourth grade class to tell what they need in the way of help.
- Creating opportunities for the fourth graders to organize to help.
- Arranging time for the groups to work together.

The students may be asked to help first grade students decide what to recycle. Possible materials for recycling are plastic or glass.

zinc-covered nails. Items being protected from decomposition should include wood, grass, and possibly food. A special study of bone comparing the rate of decomposition of buried bone and bone left in the air should be started. Have the students leave one piece of bone outdoors so that it is exposed to the sun, wind, and rain and bury the remaining pieces. Unburied bone usually decomposes faster than buried bone.

When the students complete Activity 4.5.6 PRESERVING FOODS, they can bury some of their products for unearthing in grade 5.

STUDENT ROLES

Archeologist
Chemist
Biologist
Paleontologist

MATERIALS

Plastic-mesh bags
Shovel
Protective materials suggested by the students
Grade 3 Science Record Books
Student Page 4.9.1 UNEARTHING AND BURIAL

PRODUCTS

Reburied materials
Completed Student Pages

PROCEDURES

1. **Have the students find the records of what was buried at the end of grade 3. These should be in their grade 3 Science Record Books.**

   Have the students
   - Predict what the different materials will look like when unearthed.
   - Identify the spot where they think the burial was made.
   - Look for surface evidences that a burial might be at the spot they identify. (Such things as depressions or ants.)

2. **Have the students dig up the buried materials, inventory them, and record their observations. Have them use Student Page 4.9.1 UNEARTHING AND BURIAL.**

   Ask such questions as
   - How did your third grade predictions work out? Why?
   - How much decomposition took place in the grass that was protected?
   - How successfully was the wood preserved? What method was used to preserve it? What does this suggest for the wood preservation industry?
   - How successfully was the food preserved? What could you do next time to better preserve it?

3. **Have the students prepare for a new burial.**

   Have them
   - Give the unearthed materials protection as needed.
   - Predict what will happen to buried bone and bone that is left in the air. (Usually buried bone decomposes very slowly while bone exposed to the air decomposes relatively rapidly. Make sure the students leave their unburied bone in a place where it will be exposed to wind and weather.)
   - Decide what new materials they wish to test in the burial.
   - List the materials to be buried.
   - Make a map of the burial site.
   - Predict what the materials will look like on unearthing.

4. **Have the students carry out the new burial.**

EXTENSIONS

Have the students do research to find out
- What silage is, how it is made, and why it is made.
- What hay is, how it is prepared for storage, and what it is used for.
- How bone is fossilized.

DASH

Name ____________________

Date ____________________

STUDENT PAGE 4.9.2 RECYCLING PROJECT

Describe your recycling project.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.9.1 UNEARTHING AND BURIAL

1. Using the grade 3 records, list what was buried and your predictions about decomposition. Record your observations of what you actually found.

ITEMS	PREDICTIONS	OBSERVATIONS

2. Record new ways you treated items to preserve them.

____

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Name ______________________

3. Draw a map of the new burial site.

4. List the things that were buried and your predictions of what will happen to them over the next burial period.

THINGS BURIED	PREDICTIONS

DASH

Name_______________________

Date_______________________

STUDENT PAGE 4.9.2 RECYCLING PROJECT

Describe your recycling project.

835

DASH

GRADE FOUR
CLUSTER 10

Matter, Space, and Construction

4.10.1 Linear Measurement
4.10.2 Volume Measurement
4.10.3 Mass Measurement
4.10.4 Collecting Rocks
4.10.5 Hardness of Rocks
4.10.6 Specific Gravity
4.10.7 Rocks and Sharp Edges
4.10.8 Making Tools from Rock
4.10.9 Making Fishing Tools
4.10.10 Clowns: Things That Float
4.10.11 Clay
4.10.12 Fire and Pottery
4.10.13 Air and Fire
4.10.14 Fire and Oxygen
4.10.15 Properties of Gases

ACTIVITY 4.10.1 LINEAR MEASUREMENT

OBJECTIVES

The students

- Make a copy of the class standard meter on paper tape.
- Calibrate their meter tape in decimeters, centimeters, and millimeters.
- Make a meter-string can.
- Calibrate their meter-string in meters, decimeters, and centimeters.
- Use the Pythagorean method of parallels or their own techniques in calibration.

BACKGROUND

Each year DASH students make their own measuring tools using standard distances and masses. Work in the fourth grade is different because a greater degree of precision is expected from the devices. Here the students make a paper meter tape and a meter-string can with a string at least 10 meters long. In the measurement series there are four activities: 4.10.1 LINEAR MEASUREMENT, 4.6.1 GROWTH CHART AND AREA MEASUREMENT, 4.10.2 VOLUME MEASUREMENT, and 4.10.3 MASS MEASUREMENT. When possible, follow this order of activity development.

Meter Tape

To provide a context of exploration and invention before starting the activity, remove all metersticks from the room. Draw a line 1 meter long on the board or on a piece of paper. Mark this line as carefully as you can. Have the white of the chalk or the black of a pencil mark frame the interval of 1 meter. This is the class standard meter. Have each student make a copy on cash register tape. These copies should then be calibrated, folded, and stored for ongoing classroom use. Calibrate the meter in decimeters, the first decimeter in centimeters, and the first centimeter in millimeters.

To simplify construction, the tape can be folded in four parts of 25 cm each. A 25-cm segment can be readily subdivided into centimeters using the Pythagorean method of parallel. See Figure 4.10.1(1). Millimeters can be marked using a stack of file cards. A stack of four 3 x 5 cards is about 1 mm thick. The horizontal lines on the edges made by stacking the cards can also be used with the Pythagorean method to divide the centimeters into millimeters.

Meter-String Can
If the students have not had DASH previously, it will be helpful to show them a sample meter-string can. See Figure 4.10.1(2). Have them calibrate the meter farthest from the can in decimeters and the farthest decimeter in centimeters.

To ensure that the markings on the string have some degree of permanency, have the students encase each meter mark and the entire last meter of string in masking tape and calibrate the tape.

STUDENT ROLE

Physicist

MATERIALS

Meterstick
Coffee or similar can with plastic lid
String
Masking tape
Washer or other object to secure string in the can
Notebook paper
Pencil to mark tape
Cash register tape
File
Student Page 4.10.1 LINEAR MEASUREMENT

PRODUCTS

Calibrated meter
Calibrated metric line on a meter-string can
Completed Student Pages

PROCEDURES

1. **Explain to the students that because there are no metersticks available, you have borrowed one and marked off 1 meter in chalk or pencil for class use. Discuss the problems this presents.**

   Ask such questions as
   - What could happen to our standard because the meter is marked off in chalk or pencil?
   - How can we make a paper copy of the standard meter?
   - How can we be sure that our copies are the same as the standard?

2. **Have the students copy the 1-meter marks on paper tape. Have them explore subdividing their paper copy into 10 divisions, or decimeters, and then dividing the first decimeter into 10 centimeters and the first centimeter into 10 millimeters.**

   Have them
   - Explore their own techniques for subdividing the tape.
   - Report and discuss their successes and problems.
   - Observe a demonstration of how you divided your tape using the Pythagorean method. (Demonstrate only after they have tried to divide the tape.)

3. **Have the students describe how they subdivided their paper copy into decimeters, centimeters, and millimeters.**

   Have them
   - Compare their copies of the meter.
   - Agree on a class standard.
   - Correct their copies against the class standard.

4. **With the class compare the class standard meter and its subdivisions against a commercial meterstick.**

Ask such questions as
- How close is our class standard to the commercial meterstick? (The class standard will normally be very close. If it isn't, corrections can be made.)
- Is the commercial meterstick a perfectly accurate meter? (Get at the idea that it is a copy, probably a copy of a copy, and that every time we copy something there will be slight errors.)
- When we measure the length of something, what do we mean? (Work to the idea that we are comparing something with a standard.)
- Are there other standard measurements of length? (Point out that our common U.S. system is another system. It uses inches, feet, and yards.)
- Which unit in the U.S. system is similar to the meter? (Observe that a meter is about 1 yard long.)
- How accurate are our paper copies of the meter? (Explore the idea that they are about as accurate as the one we copied and will work well for our needs.)

5. **Explain to the students that they will also need a metric linear measurement device 10 meters long. Discuss how to make a meter-string can and how to calibrate it.**

Ask such questions as
- How can we secure the string in the can?
- How can we keep the ends of the string from fraying? (Knot the ends. If nylon string is used, melt the ends with a flame.)
- From where to where do we measure 10 meters? (From the can to the knot at the end of the string.)
- How long should the string be? (Ten meters plus enough extra length to secure the string inside the can and tie a knot on the end.)
- How can we make a permanent mark on the string? (Place tape at the points to be marked.)
- Where would the first meter be? At the can end? At the free end? Why? (Work to the idea that it should be at the free end. Because this is where the string first comes off the can, it is the part of the string that will be used in most measurement.)

6. **Have the students make their meter-string can.**

Have them
- Mark off the string in meters, cover the meter points in tape, and re-mark to ensure permanency.
- Enclose the meter farthest from the can in tape and calibrate it in decimeters.
- Calibrate the first decimeter in centimeters.
- Check the cans and markings for accuracy by comparing them.

7. **Summarize the activity. Have the students complete Student Page 4.10.1 LINEAR MEASUREMENT.**

Ask such questions as
- When would indigenous peoples have used linear measurement? (Work to the idea of anytime they tried to get two things the same length.)
- What could indigenous peoples have used to make linear measurements? (A stick or other straight object that could be marked.)
- How could we measure the distance around our head? (Get at using the string or tape to wrap around our head.)
- What advantage does a meter tape or meter string have over a meterstick. (The string can wrap around things.)
- What advantage does the meterstick have over the meter string or meter tape? (Work to the idea that we must stretch the string out straight, and this is difficult to do. The stick is already straight.)

EXTENSIONS

Have the students
- Calibrate a yard-long piece of paper by folding it. Have them mark each foot, the inches in the first foot, and 1/2, 1/4, and 1/8 inches in the first inch.
- Have the students discuss the differences in calibrating a yardstick and a meterstick.

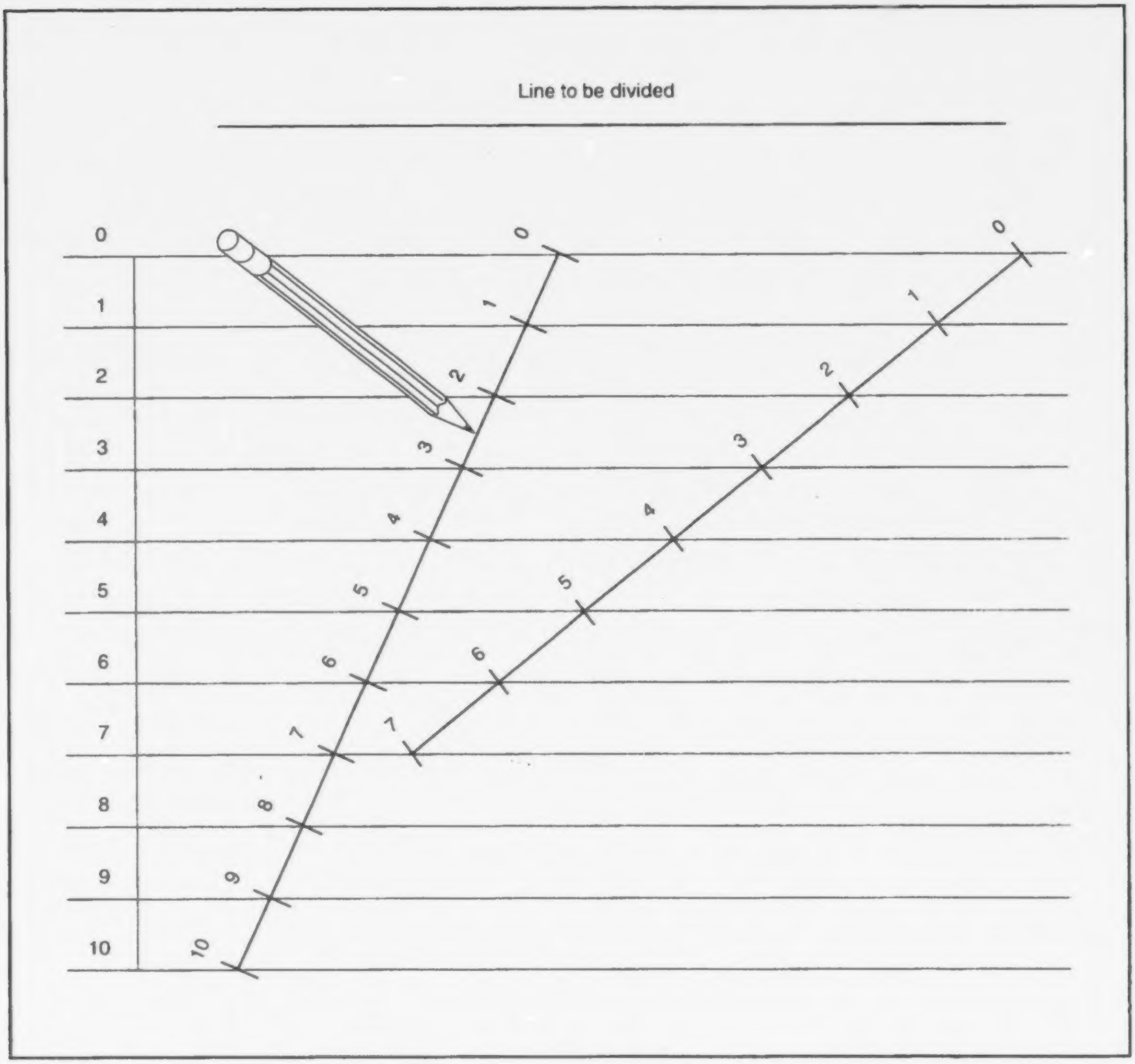
Line to be divided
0
1
2
3
4
5
6
7
8
9
10
0
1
2
3
4
5
6
7
8
9
10
0
1
2
3
4
5
6
7

Figure 4.10.1(1) A line being divided into 10 and 7 parts using the Pythagorean method of parallels

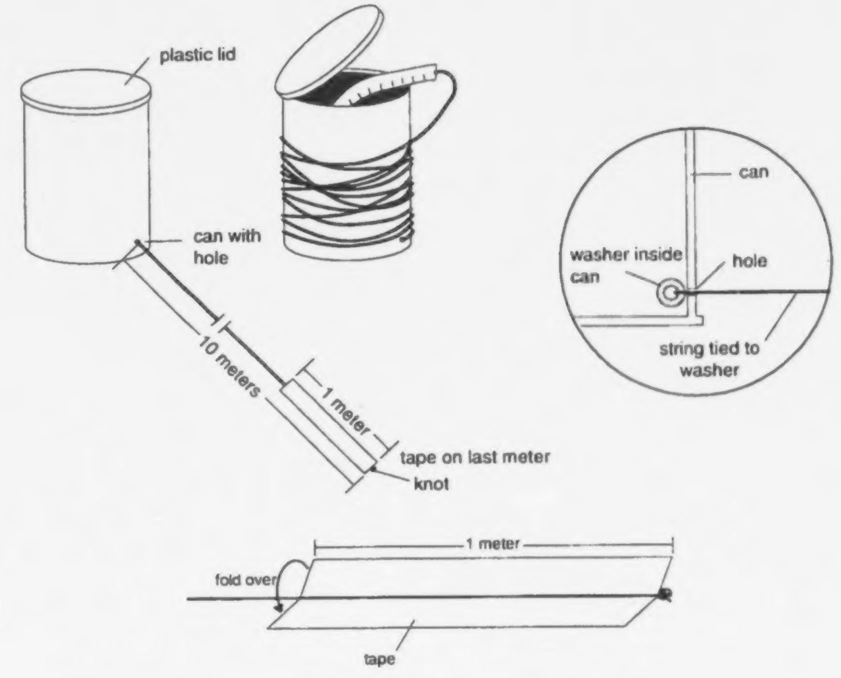
plastic lid
can with hole
10 meters
1 meter
tape on last meter
knot
can
washer inside can
hole
string tied to washer
1 meter
fold over
tape

Figure 4.10.1(2) Making a meter-string can

BEST COPY AVAILABLE

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.1 LINEAR MEASUREMENT

1. **Describe how you subdivided your paper-tape copy of a meter into decimeters, centimeters, and millimeters.**

2. **Describe how you made your meter-string can.**

ACTIVITY 4.10.2 VOLUME MEASUREMENT

OBJECTIVES

The students
- Make and calibrate a set of graduated metric cylinders.
- Calibrate cylinders using the Pythagorean method of parallels or their own techniques.

BACKGROUND

This is the third activity in the sequence on measurement. It follows Activities 4.10.1 LINEAR MEASUREMENT and 4.6.1 GROWTH CHART AND AREA MEASUREMENT and precedes 4.10.3 MASS MEASUREMENT. In this activity the students use their knowledge of volume and subdivision of lines to calibrate a set of graduated cylinders.

Standard Volume and Copies

Provide a standard 500 mL of liquid. Use the contents of an unopened commercial half-liter (500-mL) bottle of soda or other liquid. Have the students permanently mark the bottle as a class standard so that it will always deliver 500 mL. Have them fill and mark other containers they will use as their personal graduates after comparing them with the class standard. The graduates can then be calibrated in smaller increments.

The students calibrate two containers: one, a straight-walled glass or plastic container to deliver 500 mL; the second, a straight-walled translucent or clear-plastic 35-mm film canister or pill vial to deliver 20-mL. The containers should have dimensions as uniform as possible.

Calibration

A 500-mL cylinder can be calibrated in 10-mL increments by using either of the following techniques:
- Pouring the contents of the cylinder into separate containers and then comparing and equalizing the heights of the liquid. See Figure 4.10.2.
- Using the Pythagorean method. See Activity 4.10.1 LINEAR MEASUREMENT. This is the quickest, most direct, and accurate method if a straight-walled cylinder can be found.

For greater accuracy, calibrate the 20-mL graduate into 2-mL increments using the Pythagorean method.

Precision

As in the case of the standardized meter, we do not need a highly precise copy of a commercial graduated cylinder for our studies. The initial 500 mL of liquid will have commercial accuracy. Within the range of measurements the students will need to make with their graduates, the classroom standard will be adequate.

STUDENT ROLES

Physicist
Instrument maker

MATERIALS

Unopened clear plastic 500-mL bottle of soda or other liquid
Metric rule
500-mL (pint) translucent or clear plastic or glass jars with straight-sides (Large POG storage containers are ideal.)
Clear or translucent plastic 25- to 30-mL pill vials with straight sides or 35-mm film canisters
Narrow plastic tape for labeling
Student Page 4.10.2 VOLUME MEASUREMENT

PRODUCTS

Class standard 500-mL container
Sets of student-made graduated cylinders (500-mL and 20-mL)
Completed Student Pages

PROCEDURES

1. Discuss using and making a graduated cylinder.

Ask such questions as

- What do we use a graduated cylinder for?
- How have we calibrated our graduates in the past? (By using standards and dividing known quantities of water into equal parts.)

2. **Provide an unopened clear or translucent plastic 500-mL bottle of soda or other liquid.**

   Ask such questions
   - How much liquid is in the bottle?
   - How do we know? (Get at the idea that the volume is shown on the bottle, and commercial volumes are required by law to be precise.)
   - How might we use the bottle and its contents as a standard? (Work to the idea of marking the initial level of the contents, emptying the bottle, and refilling the bottle as needed.)
   - How might we calibrate a straight-walled jar to make a 500-mL graduate?

3. **Have the students explore ways to calibrate the 500-mL jar to show 50-mL increments. Have them share their techniques and compare their calibrations. After comparison, have them decide on a standard and mark their graduates.**

4. **Have the students explore ways to calibrate their first 50-mL interval to show 10-mL increments. Have them share their techniques, standardize their measurements, and mark their jars.**

5. **Have the students explore ways to use a straight-walled plastic medicine vial or film canister to make a 20-mL graduated cylinder calibrated to show 2-mL increments. Have them share their techniques, standardize their measurements, and mark their cylinders.**

6. **Summarize the activity with a discussion of liquid volume measurement. Have the students use Student Page 4.10.2 VOLUME MEASUREMENT to describe their work.**

Ask such questions as

- When would it be important for indigenous people to make liquid volume measurements?
- How could a liquid volume measurement be made without using a graduate? (Get at the fact that any container can be used as a standard.)
- What is the U.S. unit of liquid volume measure? (The quart or gallon.)
- How do the quart and liter compare in volume? (The quart is slightly larger than the liter.)

EXTENSIONS

As a science center activity have the students

- Calibrate a quart graduate to show pints, cups, and teaspoons.
- Calibrate a 1000-mL graduate to show 20-mL intervals.

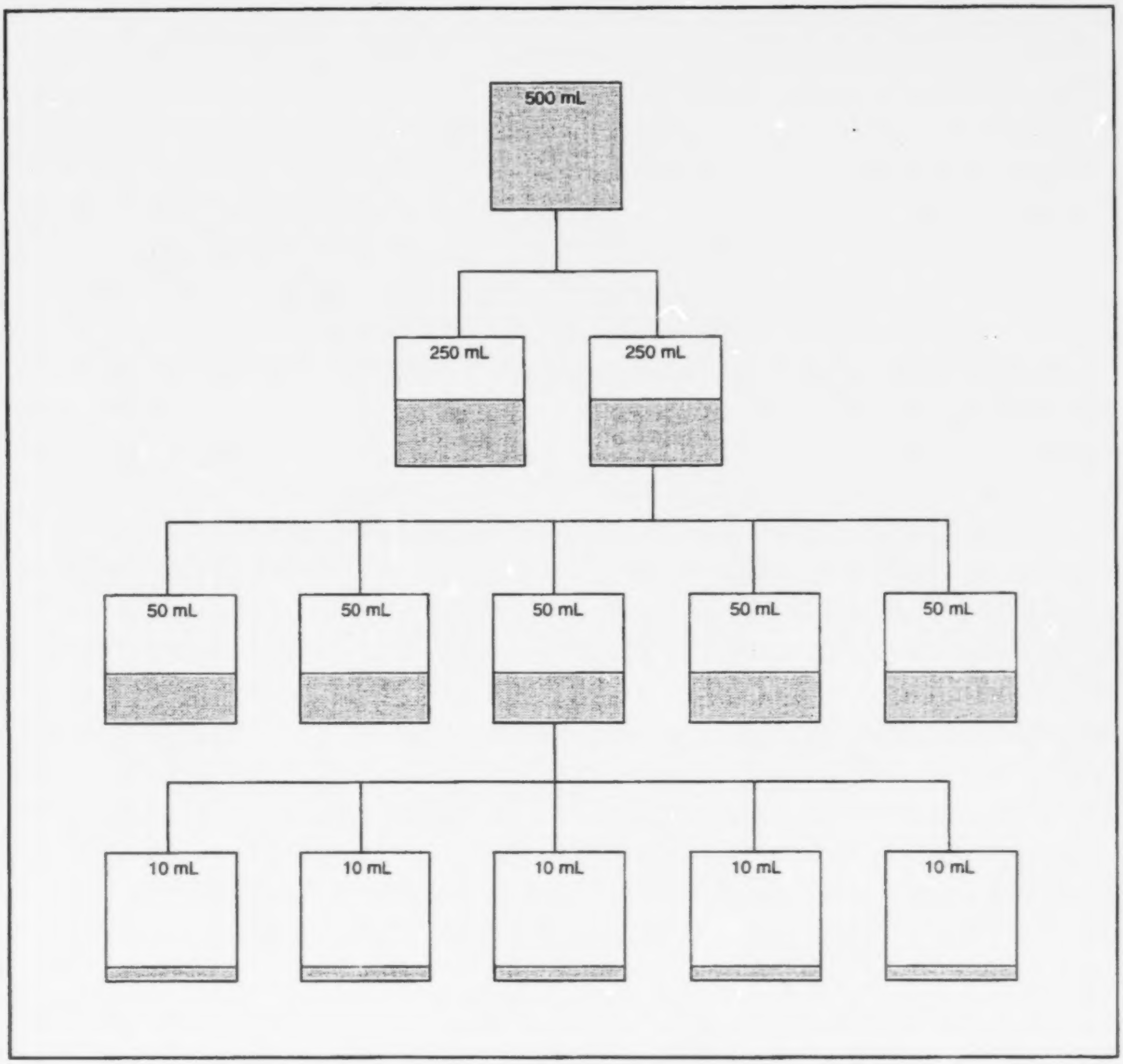
500 mL
250 mL
250 mL
50 mL
50 mL
50 mL
50 mL
50 mL
10 mL
10 mL
10 mL
10 mL
10 mL

Figure 4.10.2 Subdividing volumes by comparing and equalizing the heights of liquid

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.2 VOLUME MEASUREMENT

1. Describe how you calibrated a 500-mL container.

2. Describe how you calibrated a 50-mL interval in 10-mL increments.

3. Describe how you calibrated your 20-mL graduated cylinder in 2-mL increments.

ACTIVITY 4.10.3 MASS MEASUREMENT

OBJECTIVES

The students
- Make a metric balance.
- Make and use metric counterbalances.

BACKGROUND

This is the last of four activities on measurement. The other three activities in the series are 4.10.1 LINEAR MEASUREMENT, 4.6.1 GROWTH CHART AND AREA MEASUREMENT, and 4.10.2 VOLUME MEASUREMENT.

Mass

The common unit of measure of the amount of matter in a thing is the **gram** (g). A gram is a unit of mass. Unless part of an object is chipped away or removed, its mass does not change. Mass can be measured by using a balance to compare things with a standard mass.

Prototype Balance

Before beginning the activity, the teacher or a group of students should build a prototype balance. The design suggested here is simple and quickly put together. See Figure 4.10.3(1).
- **Base**—Use the corner of a heavy corrugated cardboard box 25–30 cm (10–12 in) high. Because the balance will often be used to measure the mass of water, tape the corrugated edge and paint the base.
- **Pivot**—Use a coat hanger or other stiff wire. Drive the ends of the wire deeply into the corrugated cardboard.
- **Balance arm**—Use a solid wood or plastic ruler that has three holes, one in the center and the others two equal distances down the arm. Where possible, get rulers with holes the same size. Stabilize and adjust the balance with clothespins at the end of the balance arm.
- **Weighing pans**—Use soft plastic drinking cups.
- **Pan hangers**—Use heavy paper clips.

The balance can be taken apart, folded, and stored until needed.

Water As a Counterbalance

In the metric system, one milliliter, or one cubic centimeter, of water has a mass of 1 gram at 4°C. Because the mass of water changes little over the range of temperature we use in class, we can use water as a counterbalance, and we can use a graduated cylinder to measure the water. For example, 160 mL of water has a mass of 160 grams; 80 mL of water has a mass of 80 grams. Though it can be used as a counterbalance, water is difficult to measure accurately. Because of this, it is suggested that modeling clay be used to make counterbalances whenever possible.

Modeling Clay Counterbalance

Use 160 mL of water in one pan to measure out 160 grams of modeling clay in the other pan. With this large volume of water, inaccuracy of measurement will be small in relation to the total mass. To ensure that all masses are the same, make a class standard 160-gram mass of clay. To preserve the standard, cover it with plastic wrap after removing enough of the clay to compensate for the mass of the plastic. Have each group make its own copy of the standard. See Figure 4.10.3(2).

Divide the clay so that there are 80 grams in each pan. Cover one mass with light plastic wrap. Remove just enough of the clay to compensate for the mass of the plastic.

Divide the other 80 grams of clay into two 40-gram masses. Make one a standard 40-gram counterbalance. Cover it with plastic wrap and remove some of the remaining clay to adjust for the mass of the wrap. See Figure 4.10.3(2). Make 20-gram and 10-gram counterbalances the same way.

Cardboard As a Counterbalance

Make the last 10 grams of clay into two 5-gram counterbalances. Cover both with plastic wrap. Provide oaktag or tagboard strips about 2 cm wide and 15–20 cm long. Find the length of strip that will balance the 5 grams of clay. Progressively cut the strip into shorter lengths until balance is reached. Short pieces can be added if too much is cut off. Divide a strip of oaktag with a mass of 5 grams into five equal segments. The Pythagorean method can be used to mark off equal segments. Each segment will have a mass very close to 1 gram.

STUDENT ROLE

Physicist

MATERIALS

Waxed paper
Corrugated cardboard box
Pliers
Heavy wire (coat hanger)
12-inch wood or plastic ruler with 3 holes
Heavy-duty paper clips
Soft plastic drinking cups
Modeling clay
Paint to seal cardboard
Clothespins
Masking tape
Brick
20-mL graduate
Water
Plastic wrap
2-cm-wide strips of oaktag or tagboard
Student Page 4.10.3 MASS MEASUREMENT

PRODUCTS

Balances
Counterbalances
Completed Student Pages

PROCEDURES

1. **Introduce the need for balances that will measure the mass of objects to a gram. Discuss the structure of such a balance.**

   Ask such questions as
   - How have we constructed balances in the past? (Usually they have been "justice type" balances with a string at the center and cups suspended from clamps at the end of a beam. The beam was usually a ruler.)
   - How could we get a more sensitive balance? (Work to the ideas of substituting a smooth or very sensitive pivot at the center, making the system stationary, and making a pointer that tells when the balance is balanced.)

2. **Demonstrate a prototype of a sensitive equal-arm balance.**

   Ask such questions as
   - How is the balance similar to the one you have used before? (It still has a pivot or fulcrum in the center, a beam, and holders suspended at either end.)
   - How could we be sure when we have reached balance? (Get at the idea that we could add a pointer that would tell us when the beam is at the balance point.)
   - How could we stabilize the balance so that it will not fall over? (Work to the ideas of clamping it or weighting it down with a book or brick.)

3. **Have the students make a version of the prototype balance and invent a way to show when it is in balance.**

   Have them
   - Demonstrate how their balance operates by placing an object in one cup and counterbalancing it with water in the other cup.
   - Exchange cups to make sure the cups are of equal mass.

4. **Discuss how a set of counterbalances can be made.**

   Ask such questions as
   - Does anyone know the mass of a milliliter or cubic centimeter of water? (Introduce the idea that from the freezing temperature at 0°C to well above room temperature (between 27°C and 30°C), a cubic centimeter or milliliter of water has a mass very close to 1 gram.)
   - What could we use as a counterbalance to measure the mass of an object? (Work toward the idea of using a measured volume of water.)

5. **Have the students make counterbalances out of modeling clay. Have them make counterbalances of 10, 20, 40, and 80 grams.**

   Have them
   - Measure out 160 grams of modeling clay using water as a counterbalance.
   - Divide the 160-gram mass into two 80-gram masses. Enclose one in plastic wrap. Adjust so that the total mass is 80 grams.

- Divide the remaining 80-gram mass into two 40-gram masses. Enclose one counterbalance in plastic wrap. Adjust the mass to 40 grams.
- Divide the remaining 40-gram mass into two 20-gram masses. Enclose one in plastic wrap.
- Divide the remaining 20-gram mass into two 10-gram masses. Enclose one in plastic wrap.

6. **Have the students make 1-gram counterbalances out of cardboard.**

Have them
- Divide a 10-gram mass into two 5-gram masses.
- Determine the length of a 2-cm-wide oaktag strip that is equal in mass to the 5 grams of clay.
- Divide the oaktag with a mass of 5 grams into five equal 1-gram counterbalances.
- Invent a holder for their personal set of counterbalances.

7. **Have the students exchange counterbalances with each other to check the mass of their group set.**

8. **Summarize the investigation. Have the students use Student Page 4.10.3 MASS MEASUREMENT.**

Ask such questions as
- How did we arrive at our 1-gram mass? (Go through the steps.)
- What is the gram based on? (It is the mass of 1 milliliter of water at 4°C.)
- What advantages do the clay counterbalances have over water? (They are permanent and easier to handle.)
- When would indigenous people have needed to measure mass? (When loading a boat or estimating how much they could carry.)

EXTENSIONS

- Set up a weighing station and have the students measure the masses of different objects.
- Have the students make counterbalances of 0.5 and 0.1 grams.

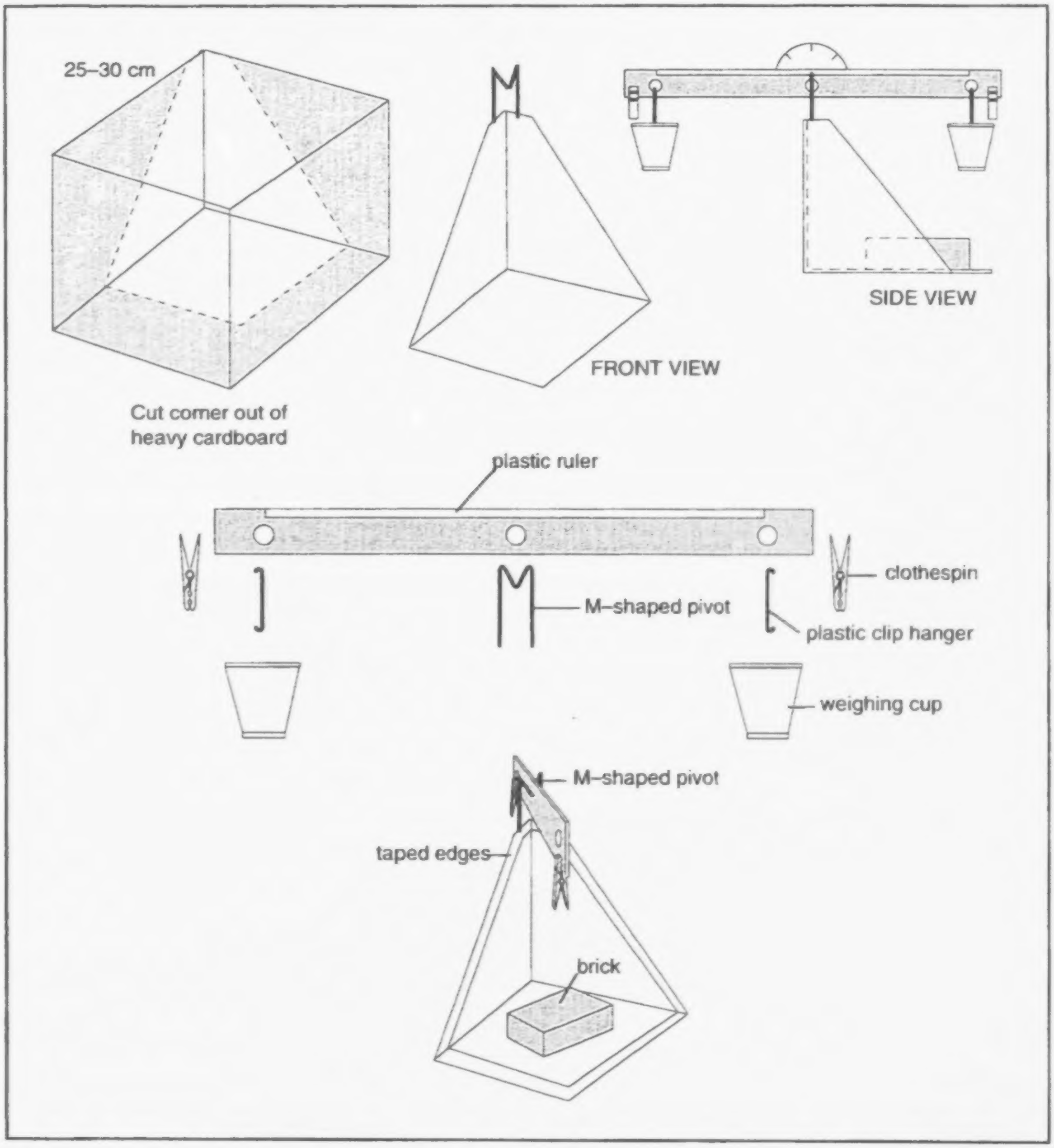
25–30 cm
Cut corner out of heavy cardboard
FRONT VIEW
SIDE VIEW
plastic ruler
clothespin
M–shaped pivot
plastic clip hanger
weighing cup
M–shaped pivot
taped edges
brick

Figure 4.10.3(1) Assembling a balance

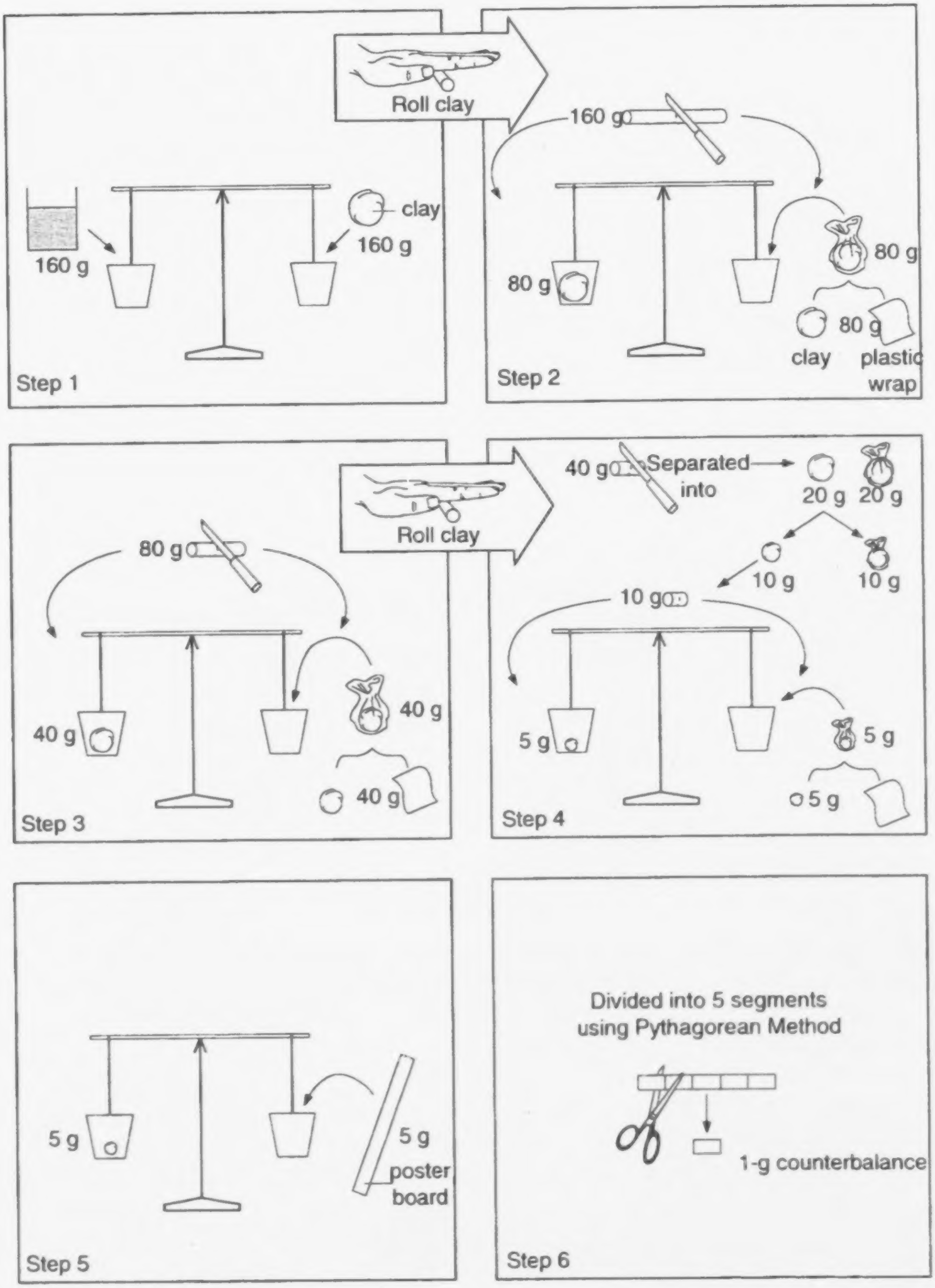
Roll clay
160 g
clay
160 g
Step 1
160 g
80 g
80 g
80 g
clay
plastic
wrap
Step 2
Roll clay
80 g
40 g
40 g
40 g
Step 3
40 g
Separated
into
20 g
20 g
10 g
10 g
10 g
5 g
5 g
5 g
Step 4
5 g
5 g
poster
board
Step 5
Divided into 5 segments
using Pythagorean Method
1-g counterbalance
Step 6

Figure 4.10.3(2) Steps in making counterbalances

Name________________________

Date________________________

DASH

STUDENT PAGE 4.10.3 MASS MEASUREMENT

1. Draw your balance and tell how it works.

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____

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____

____

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2. Explain how you made your counterbalance.

____

____

____

____

____

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4.10.4 COLLECTING ROCKS

OBJECTIVES

The students
- Make a concept map of the uses of rocks.
- Collect rocks.
- Classify rocks by their accidental and permanent properties.

BACKGROUND

This is the first of a series of activities designed to look at the properties of rocks that make them useful materials for modern and Stone Age technology. Activities in the sequence are 4.10.4 COLLECTING ROCKS, 4.10.5 HARDNESS OF ROCKS, 4.10.6 SPECIFIC GRAVITY, 4.10.7 ROCKS AND SHARP EDGES, 4.8.4 PRESSURE, SHARP EDGES, AND POINTS, and 4.10.8 MAKING TOOLS FROM ROCK. The more traditional investigation of rocks in relationship to their origins (volcanic, sedimentary, and metamorphic) and their mineral content is saved for DASH 5 and 6.

Classifying Rocks

In this activity the students are asked to separate rocks by their accidental and permanent properties. They first separate the rocks by accidental properties produced by weathering such as size and roundness. Next they subdivide them by their permanent properties such as luster, color, kinds of crystals, hardness, magnetic properties, fracture type, and specific gravity.

Breaking Rocks

If it is necessary to break rocks, avoid the problem of flying pieces by breaking them in the stamp mill rock crusher used DASH 2 for making soil. See Figure 4.10.4(1). A single blow of the mill will break most rocks. Goggles or face masks should be worn when rocks are broken.

Dichotomous Key

Finally, the students are asked to make a dichotomous key to identify their rocks. This will be a review activity for some students. They should be reminded that dichotomous keys are built around a hierarchy of double categories. The top category is most general and describes all the objects in the set. Each subordinate pair of categories divides the previous category in two. One category of the pair collects all the objects with a certain property. The other collects all the objects that do not have this property. This pairing continues until only one kind of object fits each description. See Figure 4.10.4(2).

STUDENT ROLE

Geologist

MATERIALS

White correction fluid to tag rocks
Stamp mill rock crusher from DASH 2
Hand lens
Rocks
Goggles
Student Page 4.10.4 COLLECTING ROCKS

PRODUCTS

Rock Concept Map
Rock collections
Completed Student Pages

PROCEDURES

1. **Make a concept map of the uses of rocks. Have the students lead the development.**

   Help them include such things as
   - Modern uses of rock in
     - Building structures.
     - Building roads.
     - Mining.
     - Gemstones.
     - Sculpture.
     - Building seawalls.
   - Ancient uses of rock as
     - Knives, axes, adzes, and arrow and spear points.
     - Hammers and throwing objects.
     - Heat holders in cooking.
     - Building materials.
     - Sculpture.

- Natural functions as
  - Mountain builders.
  - Soil formers.

2. **Help the students plan for the collection of different samples of rock. Have exemplary samples on hand.**

   Have the students
   - Decide what size samples to keep in their collection. (Preferably not larger than 3–4 cm in any direction.)
   - Record the name of the person who brought the sample.
   - Record where the sample was found.
     (Place and kind of location—in a streambed, as part of a mass of rock, in soil some distance from a streambed or large mass of rock, and so forth.)
   - Record other information as needed.
   - Invent a way to tag each sample so that it is not lost in subsequent operations. (A dab of white correction fluid with a number in it will work.)

3. **Have the students collect the rocks, clean them, record their data, and tag their samples. Where possible, they should bring in several samples of each type of rock.**

4. **Have the students sort the rocks by location of find and make preliminary observations.**

   Have them sort the rocks by location
   - In a streambed.
   - In a larger rock mass.
   - In soil some distance away from a streambed or larger rock mass.
   - Others. (This might include rock piles, rocks from roadbeds, and so forth.)

5. **Have the students compare rocks from three different locations**

   Ask such questions as
   - What are the differences between rocks from each kind of location? (Work toward the smooth roundness of stream rocks versus the angularity of freshly broken rocks and the variability of rocks found in soil. If all the rocks have been found in

roadbeds, ask how we might find out where they came from and go on to Procedure 6.)

- Why do you think the stream rocks are smooth and rounded?
- Why do you think the freshly broken rock is not rounded?
- Where do you think different rocks found in soil came from? Why? (Some may come from streams and have a rounded surface; some may come from underlying weathered rock and be relatively angular; some may come from glaciers, and so forth.)

6. **Have the students sort rocks according to properties other than accidental (location, size, and shape). These will include color, crystallinity, luster, and so forth. Have the students make their own categories.**

After the sorting is complete, summarize by asking such questions as

- What do we mean by properties? (Record the definitions in the Working Dictionary and help the students include such things as characteristics, descriptions, identifiers, something belonging to, connected with, and found in.)
- What are the properties you used to separate rocks into categories? (Put a listing on the board.)
- How would we know when we have rocks of the same type? (Get at the idea that they will have the same properties.)
- Is the location where we found a rock a property of the rock? (Get at the idea that it's a momentary property, a sort of accident. Note that a rock can be moved from location to location, but the permanent properties that distinguish the rock from other rocks remain with it and are "owned" by it.)
- Are roundness, smoothness, and angularity properties of rocks? (Work to the observation that these are properties of a rock at a particular time in its history, and these properties may be lost, depending on what happens to the rocks.)
- Do the properties of roundness, smoothness, and angularity differ from the properties of crystallinity, color, luster, and so forth? If so, how? (Develop the idea that while the first group of properties are dependent on what has happened to a particular rock, the latter properties will always be part of this type of rock.)
- How many different types of rock do we probably have?
- Are there stream-rounded rocks that have the same permanent properties as freshly broken rocks?

- How could we test this? (Work to the idea that the stream-rounded rocks can be broken and compared. Do this using a rock crusher. Be careful not to pulverize the rock.)
- Are there stream-rounded rocks that look like rocks found in soil?
- What might this tell us about the sources of soil rock? (Get at the idea that they may have come from a stream that once flowed over the area.)
- How are the uses we can put rocks to related to their properties? (Get at such things as sharp rocks are used for cutting, hard rocks for building, and so forth.)

7. **Develop the idea of a dichotomous key to separate rocks by their permanent properties.**

Before starting, ask such questions as

- Does anyone remember how you organized the properties of plants so that you could identify them? (This will go back to DASH 1, though the students may not remember the details.)
- How would you separate a set of rulers and pencils or paper clips and pencils using the idea of a dichotomous key? (Give the students sets and have them review their system of separation.)
- How can you separate the rocks you have in your collection using the idea of a dichotomous key?

8. **Have the students develop a master dichotomous key to separate rocks by their permanent properties.**

Ask such questions as

- Can you use your neighbor's dichotomous key to identify your neighbor's rocks? (Have the students exchange keys and rocks and test them out. Have groups work together to correct any problems.)
- Can you join your key with your neighbor's to identify both collections of rocks? (Have the students join their rocks with their neightbor's and come up with a common key. Have groups combine their rocks until all the rocks can be identified by one master key.)
- How might we check a master key with other samples that seem to be duplicates. (Have them make a check by using duplicates as unknowns.)

EXTENSIONS

Have the students
- Make a rock-keying center.
- Bring in new rocks and catalog them, tag them, and then key them out.
- Add to the key when different rocks are found.

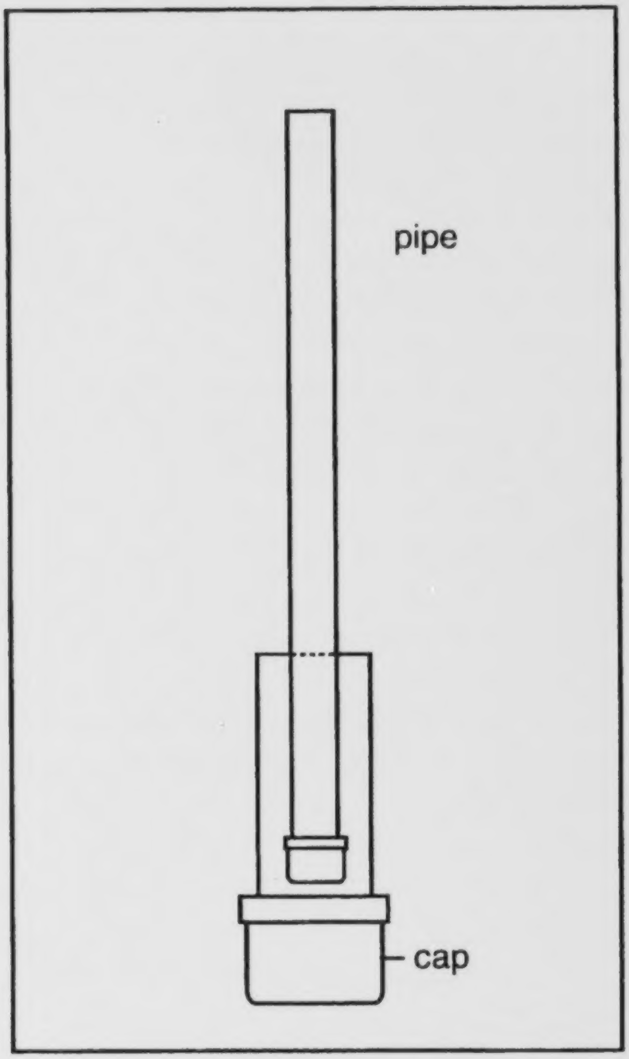
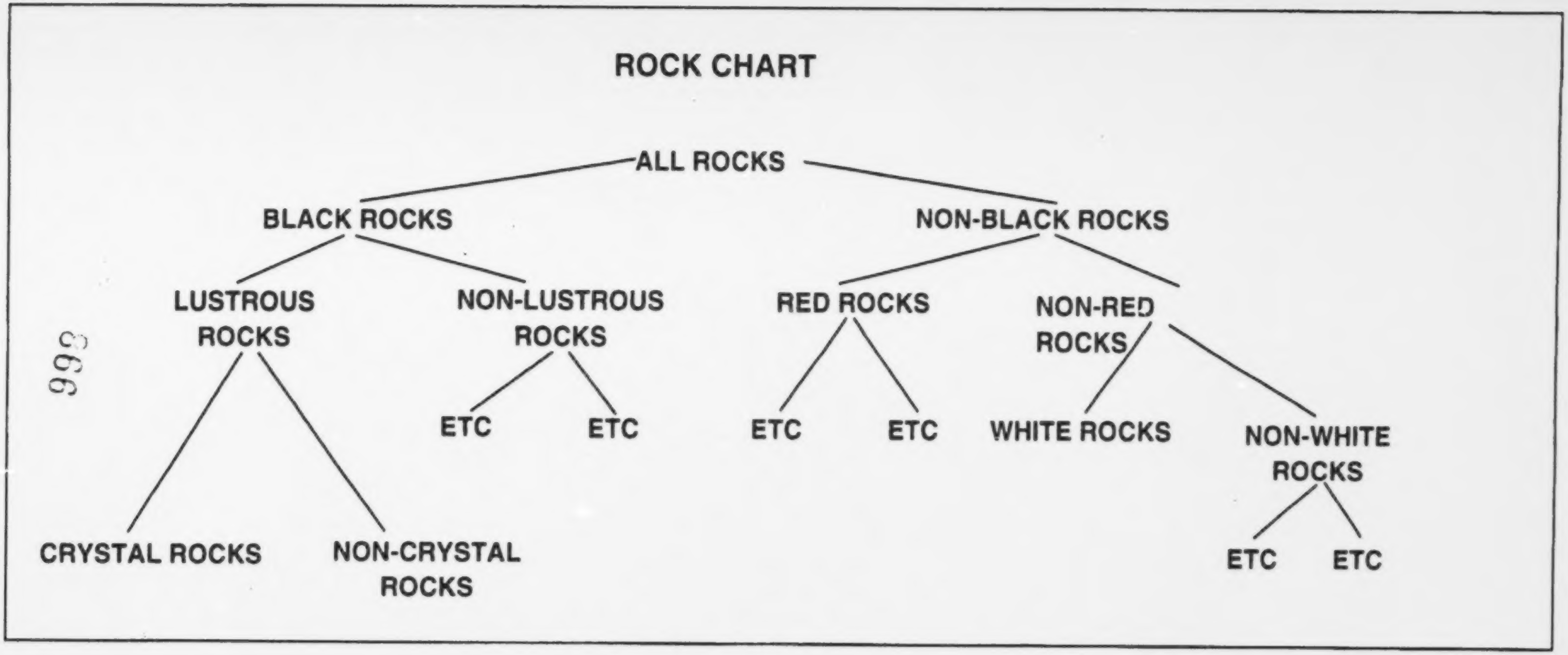


Figure 4.10.4(1) Stamp mill rock crusher



ROCK CHART
ALL ROCKS
BLACK ROCKS
NON-BLACK ROCKS
LUSTROUS ROCKS
NON-LUSTROUS ROCKS
RED ROCKS
NON-RED ROCKS
ETC
ETC
ETC
ETC
WHITE ROCKS
NON-WHITE ROCKS
CRYSTAL ROCKS
NON-CRYSTAL ROCKS
ETC
ETC

Figure 4.10.4(2) Sample dichotomous key for rocks

DASH

Name____________________

Date____________________

STUDENT PAGE 4.10.4 COLLECTING ROCKS

1. List the records we will keep on the rocks we collect.

2. List differences in rocks found a) in a streambed, b) in a larger rock mass, and c) in soil some distance from a streambed or large rock mass.

3. List the permanent properties you used to identify rocks.

4. Show the master dichotomous key you used to identify all of the rocks.

ACTIVITY 4.10.5 HARDNESS OF ROCKS

OBJECTIVES

The students
- Review distinguishing properties of rocks.
- Test rocks for hardness.
- Make a hardness scale.

BACKGROUND

This is the second of a series of activities designed to look at the properties of rocks that make them useful materials for modern and Stone Age technology. Activities in the series are 4.10.4 COLLECTING ROCKS, 4.10.5 HARDNESS OF ROCKS, 4.10.6 SPECIFIC GRAVITY, 4.10.7 ROCKS AND SHARP EDGES, 4.8.4 PRESSURE, SHARP EDGES, AND POINTS, and 4.10.8 MAKING TOOLS FROM ROCK.

In this activity the students characterize rocks by their hardness and are introduced to the Mohs (pronounced "moz") hardness scale. They determine the hardness of the rocks and add their own values to the Mohs scale.

In the Mohs scale, substances are assigned numbers according to their ability to make a scratch mark on another material. A material will scratch each of the materials with the same or a lower number and will not scratch those with a higher number. The material with the lowest number will scratch only substances that are no harder than itself. The substance with the highest number will scratch substances that are as hard as it is and all of the substances with lower numbers. Diamond has 10, the highest Mohs number, while very soft gypsum board has the low number of 2.

STUDENT ROLE

Geologist

MATERIALS

Rocks
Penny
Gypsum board (wallboard)
Glass

Steel file
Student Page 4.10.5 HARDNESS OF ROCKS

PRODUCTS

Class list of rocks ranked by the Mohs hardness scale
Completed Student Pages

PROCEDURES

1. **Review the distinguishing properties of rocks with the class.**

   Ask such questions as
   - What ways have we found so far to classify different kinds of rocks?
   - What kinds of properties would be important to people making tools out of rocks?
   - How would hardness be important to toolmakers? (Get at such ideas as harder things cut softer things.)

2. **Develop a working definition for a scale of hardness.**

   Have the students
   - Suggest what a scale of hardness might be.
   - Look up the word "hardness" in the dictionary under "mineral."
   - Look up the word "scale." (Work toward a definition that includes a series of steps.)

3. **Have the students make a class scale of hardness.**

   - Give the students materials with a range of Mohs hardness values.

Materials	Hardness
gypsum board	2.0
fingernail	2.5
penny	3.0
glass	5.5
steel file	6.5

- Help the students discover that a substance will scratch each of the substances with the same or a lower number and will not scratch a substance with a higher number.
- Have the students test their rocks for hardness and insert them into the ranked list of rocks.
- Have the students make a class scale of hardness based on Mohs ratings.

4. **Summarize the activity by discussing the property of hardness. Have the students use Student Page 4.10.5 HARDNESS OF ROCKS.**

Ask such questions as
- How could scratching a substance help shape it?
- How would you smooth a piece of rough wood?
- What characteristics would sandpaper need to have in order to smooth iron?
- How would the hardness of a stone be important in making stone tools?
- Do the rocks we have considered to be the same kind all have about the same hardness?
- Taking hardness into consideration, should we change our rock categories? (Have the students make changes as necessary.)
- How many kinds of rocks do we now seem to have?

EXTENSIONS

Have the students
- Set up a hardness center and keep a list of the hardness of different rocks and other objects.
- Add hardness to the properties of rocks in a rock identification center.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.5 HARDNESS OF ROCKS

1. Develop a working definition for a scale of hardness.

2. Use a class scale of hardness based on Mohs ratings. List rocks and other materials in their order of hardness.

ACTIVITY 4.10.6 SPECIFIC GRAVITY

OBJECTIVES

The students
- Review properties of rocks that might make them valuable to makers of stone tools.
- Investigate finding volume by displacement of a liquid.
- Develop a method to find specific gravity.
- Measure the specific gravity of different kinds of rocks and other objects.

BACKGROUND

This is the third in a series of activities designed to look at the properties of rocks that make them useful materials in technology. Activities in the series are 4.10.4 COLLECTING ROCKS, 4.10.5 HARDNESS OF ROCKS, 4.10.6 SPECIFIC GRAVITY, 4.10.7 ROCKS AND SHARP EDGES, 4.8.4 PRESSURE, SHARP EDGES, AND POINTS, 4.10.8 MAKING TOOLS FROM ROCK, and 4.10.9 MAKING FISHING TOOLS FROM ROCK. SPECIFIC GRAVITY is also the first in a series on floating and sinking that includes 4.10.6 SPECIFIC GRAVITY, 4.10.10 CLOWNS: THINGS THAT FLOAT, and 4.7.1 BOAT DESIGN. Activities 4.10.2 VOLUME MEASUREMENT and 4.10.3 MASS MEASUREMENT need to be completed before undertaking SPECIFIC GRAVITY.

Introducing Specific Gravity

When students are asked which is heavier, 10 grams of Styrofoam or 10 grams of water, they will most often say "The water, of course." The question produces confusion because it asks for the mass as weighed on a balance, and the mass of an object is always the same. **"A gram is a gram wherever I am."** Therefore 10 grams of Styrofoam will weigh 10 grams **"wherever you are"** as will 10 grams of water.

What is confusing the students when they answer "water" is that they are thinking of the Styrofoam's specific gravity. **Specific gravity** is a measure of how much lighter or heavier a thing is than an equal volume of water. On a scale of specific gravity, Styrofoam has much less mass than an equal volume of water has.

Measuring Specific Gravity

Specific gravity can be determined in the following way:

- **Step 1—Weigh the object on a balance.**
- **Step 2—Measure the volume of the object.** The volume of solids can be measured by submerging them in a known volume of water in a graduated cylinder. Observe how much the water level rises. This increase in volume level is the volume of the object. Volume can be reported in milliliters or cubic centimeters (1 mL = 1 cc). This process is called finding volume by water displacement.
- **Step 3—Determine the mass of water equal to the volume of the object.** In the metric system, 1 cc or 1 mL of water has a mass of 1 gram. Therefore, by measuring the object's volume we immediately know the mass of an equal volume of water. For example, 5 mL of water has a mass of 5 g.
- **Step 4—Divide the mass of the object by the mass of an equal volume of water to get the specific gravity.** See Figure 4.10.6(1).

To get good displacement data, put a rock or other object that has a volume of 25–40 cubic centimeters or milliliters into a graduated container that has a capacity of 50–100 mL. Have the students measure the volume to the nearest milliliter. The students will have to practice measuring specific gravity and talk about it for some time before the idea will be fully understood.

Specific Gravity of Water

The specific gravity of water is 1. For example, a 10-mL volume of water will have a mass of very close to 10 g from 0°C to well above room temperature. That same 10-mL volume of water will have a mass of 10 g whenever it is weighed. Dividing 10 g by 10 g, we get a specific gravity of 1. Water is the specific gravity standard 1 that all other matter is compared with.

Finding the Volumetric Equivalent of Florist's Clay

In this activity, florist's clay is suggested as a good material to show that the mass of a particular object always displaces the same volume of water. The activity calls for a plug of clay (the object) that has a volume of 20 mL. To make a 20-mL plug, cut a graduated cylinder made from a plastic film canister in half lengthwise. Spread a light coat of cooking oil over the inside surfaces of the two pieces so the clay can be removed without sticking. Rejoin the pieces and fill the graduate with clay to the 20-mL mark. See Figure 4.10.6(2).

Specific Gravity and Density

Another way to compare the amount of matter in a unit of volume is to use the measure of density. In the metric system, the specific gravity and the density of an object have the same numerical value. A rock with a specific gravity of 2.5 has 2.5 times the mass of an equal volume of water. It has a density of 2.5 g/mL. Students at this age usually find it easier to compare weights than to deal with the more abstract concept of density.

SUGGESTED ANSWERS TO STUDENT PAGE 4.10.6 ITEMS 5–9

5. A student got the following data when finding the specific gravity of some rocks. Complete the table.

	A	B	C
Mass of rock	50 g	25 g	75 g
Volume of rock and water	35 mL	35 mL	80 mL
Volume of water	10 mL	30 mL	55 mL
Volume of rock	**25 mL**	**5 mL**	**25 mL**
Mass of water equal to volume of rock	**25 g**	**5 g**	**25 g**
Specific gravity of rock	**50g/25g = 2**	**25g/5g = 5**	**75g/25g = 3**

6. Which rock in the table above weighs the least? **B**
7. Which rock in the table above has the least volume? **B**
8. Which rock or rocks in the table above have the greatest volume? **A & C**
9. Which rock or rocks in the table above have the greatest specific gravity? **B**

STUDENT ROLES

Geologist
Physicist

MATERIALS

Hammer
Florist's clay
Rocks

BEST COPY AVAILABLE

DASH 2 stamp mill rock crusher
Small pieces of wood
Small pieces of Styrofoam
Balance
Graduated containers (50–100 mL)
Graduated plastic film canisters
Cooking oil
Scissors or plastic cutters
Student Page 4.10.6 SPECIFIC GRAVITY

PRODUCTS

List of rocks and their specific gravity
Completed Student Pages

PROCEDURES

1. **Review the properties of rocks, including those that make them valuable as tools.**

   Ask such questions as
   - What properties have we found to identify different kinds of rocks? (Get at such things as color, hardness, and luster.)
   - Are there properties of rocks that might be important in making stone tools? What might these be?
   - How might the mass of a rock be important?
   - What do we mean by "mass"? (Help the students recall that mass is the number of grams an object weighs on a balance.)
   - You want to make a club to kill attacking wolves. Would you want the head of the club to be made of 500 g of Styrofoam or 500 g of rock? Why?
   - Which has the most mass, rock or Styrofoam? (Work to the idea that they have the same mass. "A gram is a gram wherever I am.")
   - What is the difference between the two? (Work to the idea that 500 g of rock is packed into less volume than 500 g of Styrofoam.)

2. **Define specific gravity as a measurement that tells us how many times lighter or heavier a thing is than an equal volume of water.**

Ask such questions as

- Do you think we would find a rock has the same, a greater, or a smaller specific gravity than water? (Record the students' predictions.)
- How can we find out which has the greater specific gravity, the rock or water? (Work toward determining the specific gravity.)
- How could we find the mass of a rock? (Get at determining its mass on a balance. Have a group of students carry out the determination.)
- How could we find the volume of the rock? (Get at such ideas as crushing the rock and putting the tiny pieces into a graduate or grinding part of the rock into a geometric shape. Have a group carry out the crushing demonstration. Hold off using water displacement until Procedure 3 unless there is an overwhelming demand to use this technique.)
- How could we find the specific gravity of the rock? (Have the students find the mass of a volume of water equal to the volume of the crushed rock and divide the mass of the water into the mass of the rock.)
- How could we find the specific gravity of water? (Work to the idea of weighing a volume of water and dividing that mass by the mass of the same amount of water. This is subtle. A 10-mL volume of water will have a mass of 10 g. That same 10 mL-volume of water weighed again will still have a mass of 10 g. Therefore, 10 g divided by 10 g is 1. The specific gravity of water is 1. Water is the specific gravity standard 1 that all other matter is compared with.)
- Do you think we would find that Styrofoam has the same, a greater, or a smaller specific gravity than water? (Get the students' predictions. This sequence can be skipped if the students are ready to move on.)
- How can we determine the specific gravity? (Go through the same steps as with the rock, granulating the Styrofoam to get its volume.)

3. **Present the problem of how to measure the specific gravity of a rock without crushing it. Have the students work in small groups.**

After they have worked with the problem for some time, ask such questions as

- Can anyone show us how you determined the volume of the rock?

(The students may not have arrived at the idea of water displacement. To help, show them that when a rock is put into a graduate partially filled with water, the water level rises. The rock has pushed water out of the way to make way for itself. We say it has **displaced** water. Then continue with the questioning.)

- How much does the water level rise when we put 20 mL of water into a graduated cylinder that already has 20 mL of water in it? (Go through the step of adding 20 mL of water to a graduate that has 20 mL water in it and find the difference between the two levels. Record the starting level and the final level. The difference in the two levels will be 20 mL.)
- If that water had been a solid with a volume of 20 mL, how much water would it have displaced? (Work for the answer 20 mL. Test the answer by making a 20 mL-plug of florist's clay. Drop it into 20 mL of water, and the water will rise to the 40-mL level. We say that the clay has **displaced** 20 mL of water.
- What would happen if we remolded our 20 mL of clay into another shape? What volume would it push out of the way? (Remold the clay plug and test to show that it will always displace 20 mL.)
- If the clay always pushes 20 mL of water out of the way, what is the volume of the clay? (Get agreement that it is 20 mL.)
- Can anyone put what we have observed into a **rule**? (Work to the idea that when an object sinks below the surface of water, it pushes out of the way or "displaces" a volume of water equal to its own volume. Record this in the Working Dictionary.)

4. Have the students apply their knowledge and measure the volume of a rock.

Have them
- Explore the measurement technique.
- Demonstrate their method.
- Critique the methods reported.

5. Have the students discuss how they could determine the mass of the water equal to the volume of the rock.

Ask such questions as
- What is the **mass** of a volume of water equal to the volume of a 20-cc or 20-mL rock? Put another way, what is the mass of the water a 20-cc rock will displace? (Have the students determine the volume and mass of the water displaced. For example, a 20-

mL or 20-cc rock will displace 20 g of water because 20 mL of water has a mass of 20 grams.)

- What is the mass of 1 mL or 1 cc of water? (One milliliter of water has a mass of one gram.)
- If we know the volume of an object in milliliters, how can we determine the mass of an equal volume of water? (Work to the idea that the mass will have the same numerical value as the volume because 1 mL of water has a mass of 1 g. A 20-mL sample of water will have a mass of 20 g.)

6. **Discuss the students' work and the steps to be followed in determining the specific gravity of an object.**

Help the students list the steps they would go through. (The list should resemble the following:

Step 1—Weigh the object on a balance.

Step 2—Measure the volume of the object. If the object is irregular, submerge it in a known volume of water in a graduated cylinder.

Step 3—Determine the mass of an equal volume of water.

Step 4—Divide the mass of the object by the mass of the equal volume of water.)

7. **Have the students determine the specific gravity of different kinds of rocks and other objects and record their data on Student Page 4.10.6 SPECIFIC GRAVITY.**

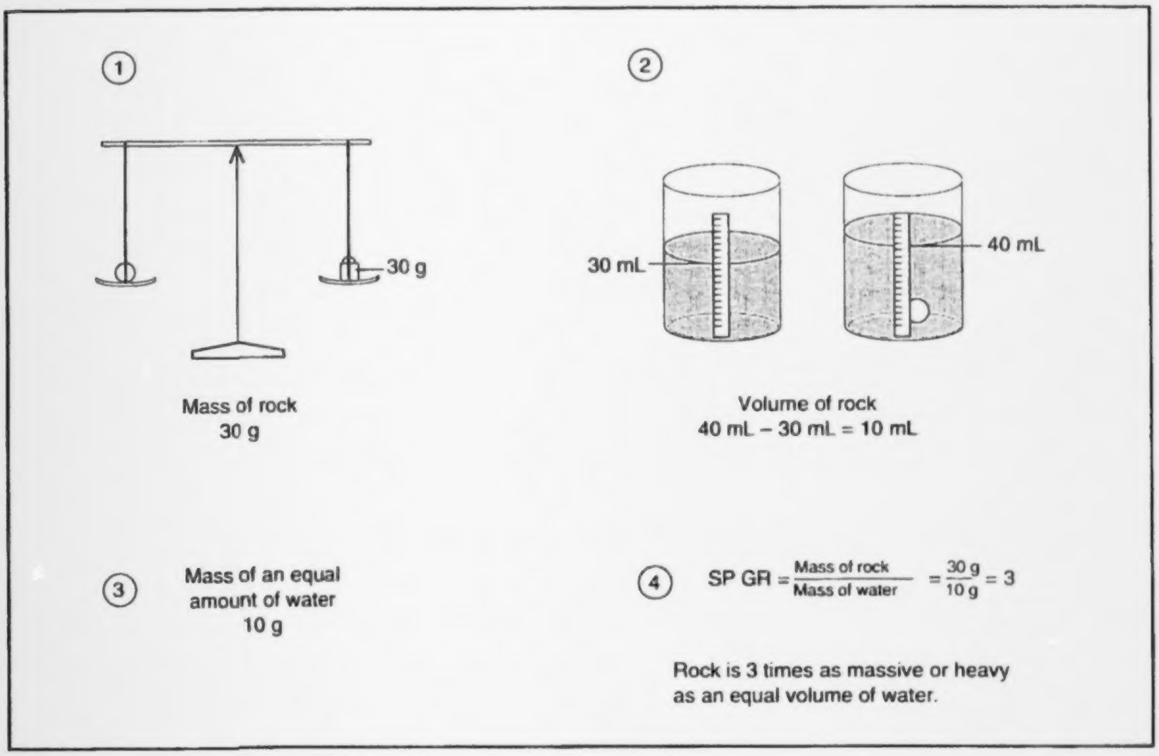
8. **Have the students determine the specific gravity of rocks in their collections.**

Ask such questions as

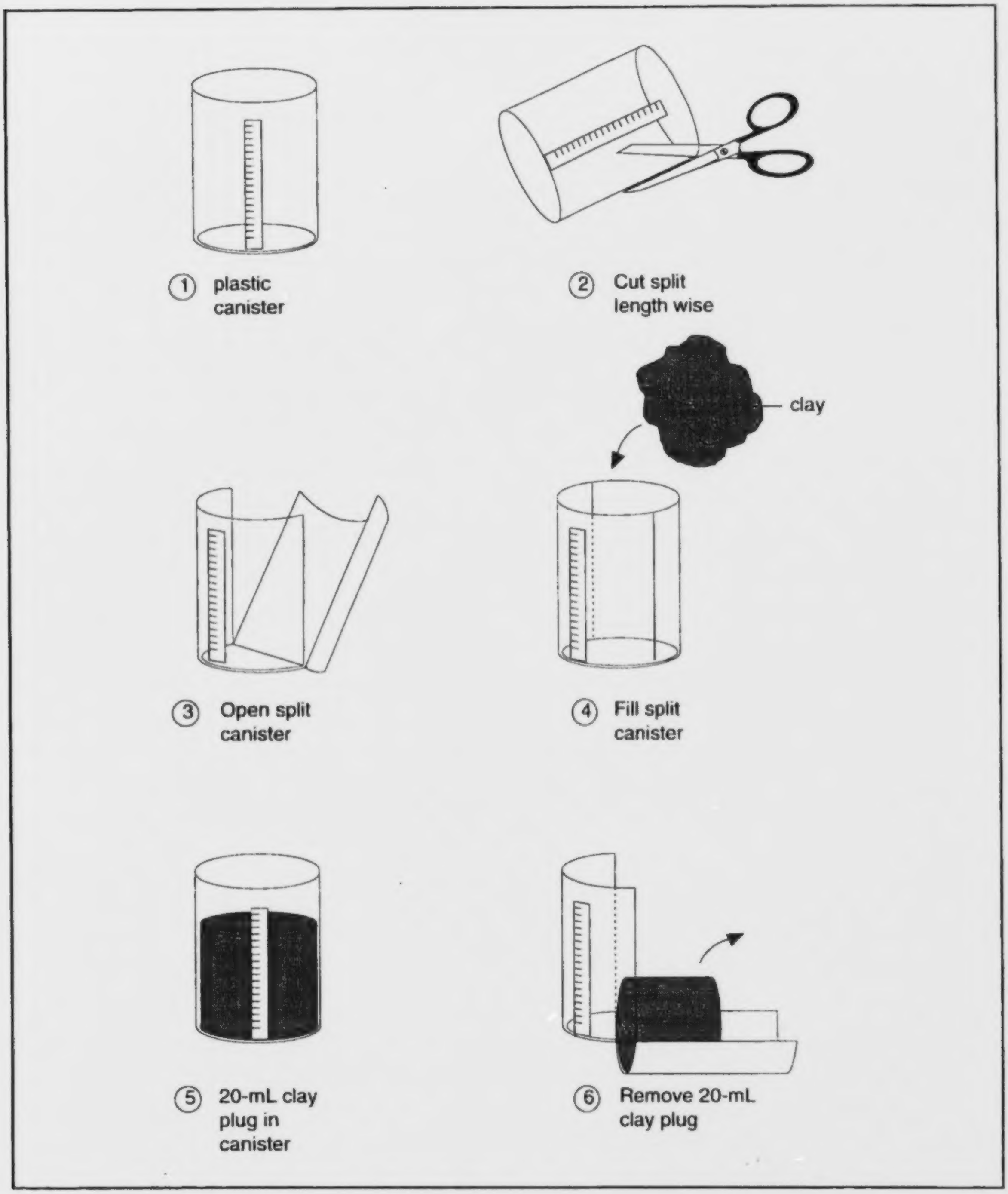
- Do rocks all have about the same specific gravity?
- Do the rocks we have considered to be the same kind have about the same specific gravity?
- Taking specific gravity into consideration, should we change our rock categories? (Make changes as necessary.)
- How many different rocks do we now have?

EXTENSIONS

- Set up a specific gravity center and have the students record the specific gravity of different kinds of materials. Add specific gravity to the characteristics of rocks.
- Have the students try to find a way of determining the specific gravity of things that float.


①
②
30 g
30 mL
40 mL
Mass of rock
30 g
Volume of rock
40 mL – 30 mL = 10 mL
③
Mass of an equal
amount of water
10 g
④
SP GR = Mass of rock / Mass of water = 30 g / 10 g = 3
Rock is 3 times as massive or heavy
as an equal volume of water.

4.10.6(1) Determining the specific gravity of a rock


① plastic canister
② Cut split length wise
clay
③ Open split canister
④ Fill split canister
⑤ 20-mL clay plug in canister
⑥ Remove 20-mL clay plug

4.10.6(2) Making a plug from florist's clay

DASH

Name____________________

Date____________________

STUDENT PAGE 4.10.6 SPECIFIC GRAVITY

1. Give your working definition of specific gravity.

2. What is the rule relating the volume of an object to the volume of water it displaces?

3. Use diagrams to describe a way to find the specific gravity of a rock.

Name ____________________

4. Make a table and record your data on the specific gravity of rocks.

	A	B	C
Mass of rock			
Volume of rock and water			
Volume of water			
Volume of rock			
Mass of water			
Mass of water equal to volume of the rock			
Specific gravity of rock			

5. A student got the following data when finding the specific gravity of some rocks. Complete the table.

	A	B	C
Mass of rock	50 g	25 g	75 g
Volume of rock and water	35 mL	35 mL	80 mL
Volume of water	10 mL	30 mL	55 mL
Volume of rock			
Mass of water			
Mass of water equal to volume of the rock			
Specific gravity of rock			

Name ____________________________

In Procedure 5

6. Which rock weighs the least? __

7. Which rock has the least volume? __

8. Which rock or rocks have the greatest volume? __

9. Which rock has the greatest specific gravity? __

ACTIVITY 4.10.7 ROCKS AND SHARP EDGES

OBJECTIVES

The students
- Review additional properties of rocks that might make them valuable for making tools.
- Test for kinds of surfaces produced when rocks are broken.
- Summarize their findings about rocks.

BACKGROUND

This is the fourth of a series of activities designed to look at the properties of rocks. Activities in the series are 4.10.4 COLLECTING ROCKS, 4.10.5 HARDNESS OF ROCKS, 4.10.6 SPECIFIC GRAVITY, 4.10.7 ROCKS AND SHARP EDGES, 4.8.4 PRESSURE, SHARP EDGES, AND POINTS, and 4.10.8 MAKING TOOLS FROM ROCK.

In ROCKS AND SHARP EDGES the students invent ways to make sharp edges on rocks. They then invent ways of rating the sharpness and durability of the edge. **Sharpness**, for example, can be ranked in terms of the ease with which wood, gypsum board, cardboard, or other material is cut. **Durability** can be rated in terms of how much cutting can be done before the edge must be rechipped.

Use only rock to chip rocks. Have the students select a hard fist-sized rock to use as a hammer. Be sure to place the rock to be chipped on a soft surface. Sand makes a good surface. When rocks are placed on hard surfaces, pieces tend to fly. Remind the students to keep the hammer in their hands and not throw it.

Eye shields and gloves should be worn.

STUDENT ROLES

Geologist
Worker of stone
Anthropologist

MATERIALS

Hard fist-sized rock to use as hammer
Rocks
Cardboard
Wood
Gloves
Goggles
Student Page 4.10.7 ROCKS AND SHARP EDGES

PRODUCTS

Sharpness and Durability Scale for Rocks
Completed Student Pages

PROCEDURES

1. **Review the properties of rocks that would make them valuable in making stone tools.**

   Ask such questions as
   - What ways have we found so far to distinguish different kinds of rocks?
   - What kinds of properties would be important to people making tools out of rocks?
   - How would the sharpness of a broken edge be important?
   - How would the durability of an edge be important?

2. **Help the students develop working definitions of sharpness and durability.**

   Have the students
   - Suggest how we might make a scale of sharpness.
   - Look up the word "sharp" in the dictionary. (Work toward the ideas of thinness of edge and ease of cutting of such things as cardboard or wood.)
   - Develop a working definition of the term "sharpness."
   - Suggest how we might make a scale of durability.
   - Look up the word "durability." (Work toward the idea of a measure of how many times an edge can be reused before it is dulled.)
   - Develop a working definition of durability.

3. Have the students invent a sharpness scale and a way to rate durability.

Have the students
- Break rocks and make chips to test.
- Test the rocks' chips for sharpness and durability.
- Make a class sharpness and durability scale.

4. Summarize the properties of sharpness and durability and have the students complete Student Page 4.10.7 ROCKS AND SHARP EDGES.

Ask such questions as
- What kinds of rock can give us the sharpest edges?
- What kinds of rocks have the most durable edges?
- Why would people in times past have wanted to know about sharpness and durability?

5. Add sharpness and durability to the properties of rocks.

EXTENSION

- Have the students investigate the ways indigenous people shaped stone tools.

Name________________________

Date________________________

STUDENT PAGE 4.10.7 ROCKS AND SHARP EDGES

1. What is your working definition of the term “sharpness”?

2. What is your working definition of the term “durability”?

3. Describe your sharpness scale.

4. Describe how you rated durability.

ACTIVITY 4.10.8 MAKING TOOLS FROM ROCK

OBJECTIVES

The students
- Review the kinds of stone tools ancient people made.
- Make stone tools needed to shape a boat.

BACKGROUND

This is part of a series of activities designed to look at the properties of rocks that make them useful materials for modern and Stone Age technology. Preceding activities in the series are 4.10.4 COLLECTING ROCKS, 4.10.5 HARDNESS OF ROCKS, 4.10.6 SPECIFIC GRAVITY, 4.10.7 ROCKS AND SHARP EDGES, 4.8.4 PRESSURE, SHARP EDGES, AND POINTS. MAKING TOOLS should be followed by 4.7.1 BOAT DESIGN and 4.10.9 MAKING FISHING TOOLS.

In MAKING TOOLS FROM ROCK the students decide what kinds of tools they will need to shape a boat from soft wood or Styrofoam. Using the knowledge gained from their previous studies of rock, they then make the tools needed.

Tell the students whether they will make their boats of wood or Styrofoam. See Activity 4.7.1 BOAT DESIGN. Samples of the material will help in deciding what tools to make. At least two kinds of tools will be needed, a sharp-edged cutting tool and a sanding tool. A sharp edge can be formed by breaking most hard rocks. The students should use only rock to break rock. They can make their sanding tools from any rough-grain rock. Eye shields and gloves should be worn when breaking rock.

STUDENT ROLES

Worker of stone
Anthropologist

MATERIALS

Hard fist-sized rock to use as hammer
Flint, chert, or obsidian
Sandstone
Limestone

Gloves
Eye shields
Student Page 4.10.8 MAKING TOOLS FROM ROCK

PRODUCTS

Stone tools
Completed Student Pages

PROCEDURES

1. **List the kinds of tools that can be made from rock. Have the students divide the list into two parts, those used by Stone Age technologists and those still used by modern technologists.**

2. **Tell the students that they will use tools made from rock and other natural materials to build a boat from Styrofoam or soft wood. No tools other than those made of rock, wood, and other natural materials should be used.**

   Help the students
   - Select the tools they will need.
   - Select the kind of rock to work.

   Discuss safety. Be sure the students
   - Use gloves.
   - Use goggles.
   - Do not use metal tools to shape rock.

3. **Have the students explore shaping their own tools from rock.**

   Have them
   - Time how long it takes to work a piece of rock into a tool.
   - Test their tools.
   - Share their techniques as they discover them.

4. **Summarize the making of stone tools.**

   Ask such questions as
   - What characteristics of a rock determine what you can do with it?

- How long did it take to make your stone tool?
- What advantages do stone tools have over our modern metal tools?
- What disadvantages do stone tools have compared with modern tools?
- How did your knowledge of the hardness of rocks help in constructing your tool?
- How did your knowledge of the sharpness of a broken edge help in constructing your tool?
- What knowledge of other properties of rock helped you in the construction of your tool?

EXTENSIONS

Have the students

- Research and report on the ways ancient peoples made tools from rock.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.8 MAKING TOOLS FROM ROCK

1. Describe or draw the tools you have decided to make and tell why you chose to make these particular tools.

2. List your tools and the time required to make them.

Tool	Time Required

3. Explain how you tested your tools.

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ACTIVITY 4.10.9 MAKING FISHING TOOLS

OBJECTIVES

The students
- Research making fishing tools from wood.
- Make a fishing tool.
- Test a fishing tool.

BACKGROUND

In this activity the students use their stone tools to make a non-injurious device to capture fish. The activity follows the series on properties of rocks useful in modern and ancient technologies. Activities in the series are 4.10.4 COLLECTING ROCKS, 4.10.5 HARDNESS OF ROCKS, 4.10.6 SPECIFIC GRAVITY, 4.10.7 ROCKS AND SHARP EDGES, 4.8.4 PRESSURE, SHARP EDGES, AND POINTS, and 4.10.8 MAKING TOOLS FROM ROCK.

In MAKING FISHING TOOLS the students decide what kinds of fishing tools they can build to capture fish without injuring them. They should have in mind the environment in which they intend to test their devices. This may be a stream, lake, a fish pond, or an aquarium. Prior to building their device, the students may need to research the ways indigenous peoples captured fish. These may include use of nets, traps, or other devices. At all times it is important to emphasize that the fish are not to be harmed in the process of being caught.

Ideally the students make all tools needed to craft their devices from stone and other natural materials from their local school, community, or home environment.

STUDENT ROLES

Hunter
Anthropologist

MATERIALS

Hard fist-sized rock to use as hammer
Flint, chert, or obsidian
Sandstone
Limestone

Gloves
Eye shields
Sticks
Vines
Leather lacings
Student Page 4.10.9 MAKING FISHING TOOLS

PRODUCTS

Stone tools
Fishing tools
Completed Student Pages

PROCEDURES

1. **Introduce the problem by stating what fish are to be caught and where they will be found. Have the students research the kinds of fishing tools they can make from wood and other natural materials.**

   Help the students
   - Select non-injurious fishing tools that they can make.
   - Decide what kinds of materials they will need. (Have them consider rocks, wood, leather, and other natural materials.)

2. **Have the students shape their own fishing tools and test them. Have them use Student Page 4.10.9 MAKING FISHING TOOLS for record keeping.**

   Have them
   - Time how long it takes to make their tools.
   - Test their tools. (Ideally, there will be an outside pond or stream that can be used. However, fish in an aquarium can be used if they are treated gently.)

3. **Summarize the making of fishing tools.**

   Ask such questions as
   - How does the nature of the wood and other materials help determine what you can make?
   - How long did it take to make your fishing tool?
   - What advantages do ancient tools have over our modern fishing tools?

- What disadvantages do ancient tools have compared with modern tools?

EXTENSION

- Have the students report on fishing techniques used by indigenous peoples.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.9 MAKING FISHING TOOLS

1. Draw a diagram of the tool you made and tell how it is intended to work.

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2. Describe how successful your tool was in catching fish. Why was this so?

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Name ______________________________

3. How did the materials you chose help shape the way you thought about the way you could make your tool?

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4. How long did it take to make your tool? ____________

5. What are the advantages and disadvantages of using natural materials to make fishing tools?

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ACTIVITY 4.10.10 CLOWNS: THINGS THAT FLOAT

OBJECTIVES

The students
- Build a life preserver for a simulated clown.
- Recognize the characteristics of a life preserver necessary for survival at sea.
- Introduce the invention of a life preserver as a technological problem.
- Work with materials that float.
- Discuss the nature of technology.

BACKGROUND

This activity introduces the study of buoyancy. It should be followed by 4.7.1 BOAT DESIGN.

The Three Clowns

The students listen to a story about three clowns and their need for a life preserver and then attempt to invent one from a Styrofoam cup. The clowns are represented by brass brads. Other materials from the Inventor's Box can be added to the Styrofoam cups if the teacher wishes.

Requirements that emerge as the students attempt to solve the problem are
- The clown (brass brad) cannot fall out of the preserver.
- The clown (brass brad) must keep its head above water.

Other requirements can be added by the teacher, for example, the need for a food supply, a water supply, a heat supply in cold weather, and so forth.

Science And Technology

The study ends with looking at distinctions between the processes of science and technology. Inventing a life preserver is a venture into technology because its goal is the practical making of things. It requires production of a particular thing, a life preserver, for a particular purpose—to prevent drowning. The success of the invention is determined by whether or not it works.

A purely scientific activity would be looking for universal explanations that would apply to all buoyancy or center-of-gravity problems. The explanation would be successful if it would allow someone to make correct predictions.

Because explanations lead to predictions, we try to test scientific predictions. A satisfactory explanation allows correct predictions often enough to make it acceptable to other scientists. A scientific explanation is always subject to challenge and change.

An example of a scientific explanation is found in the Principle of Buoyancy. Simply, it states that an object will float if its specific gravity is the same or less than the liquid or gas in which it is placed. Styrofoam has a specific gravity of 0.2, and water has a specific gravity of 1.0. Styrofoam, according to this principle, will float in water, and it does.

In **science** we attempt to find the one explanation that allows us to make correct predictions. In **technology** we try to make and or do things that work to satisfy some need under a particular set of conditions. We do not have to explain what we make.

STUDENT ROLE

Engineer

MATERIALS

1-1/2 inch brass brads
Styrofoam cups
Water containers to test the life preservers (large cups, pans, bowls, etc.)
A penny or brass washer
Student Page 4.10.10 LIFE PRESERVER

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Introduce the Clown Story.**

THE CLOWN STORY

- There were once three clowns: Brassy, Golden, and Coppertop. (Represent them as three brass brads.)
- After years of working together they went to sea on a cruise ship to relax.
- One day they all were standing at the rail of the ship and one by one revealed that they could not swim.
- Just then the ship hit an object and started to sink.
- When the captain ordered them to abandon ship, they ran in all directions at once, just like the clowns they were, and missed their lifeboat.
- Alone, they decided that they needed to find life preservers.
- Golden gave them a working definition of a life preserver as something that is round.
- Brassy found a great round brass circle (a penny).
- Brassy grabbed the round brass circle and shouted, "I'm saved!" as he leaped over the side. What do you think happened to Brassy? (Slide the brass penny between the "legs" of the clown and drop it into the water. He'll drown.)
- Coppertop said, "I'm smarter than that," and grabbed a circle of Styrofoam and leaped over the side. (The bottom of a Styrofoam cup makes a fine circle. Wrap the legs of Coppertop around the edge of the Styrofoam circle and ask "What do you think happened to Coppertop?" His head will be in the water, and he will drown.)
- Golden was left alone on the deck, and just as the boat was going down, a helicopter came over and rescued him.
- Ever since the tragedy, Golden has set up a Brassy-Coppertop memorial fund for invention of a life preserver that will save any clown in any weather in any state of consciousness.
- You have been called in as consultants to make such a life preserver.

2. **Have the students design, make, and test their life preservers.**

Have the students test their preservers by
- Flipping them over.
- Filling them with water.
- Splashing them with water.

If the students make a successful preserver, have them try a second one of different design.

3. **Once the preservers have been made, summarize the activity.**

Ask such questions as
- What are the qualities of an adequate life preserver?
- Why was it hard to solve the problem?
- Which is the best preserver? Why?
- Is making an adequate preserver a technological or scientific problem? Why? (Point out that making the preserver is for a practical end and that we judged the preserver on whether it worked. Technologists such as engineers, mechanics, and craft persons are occupied with such problems. The students acted as technologists using the knowledge of science to build an adequate preserver.)

EXTENSION

- Have the students find out how different kinds of commercial life preservers work and why they work as they do.

Name________________________

Date________________________

STUDENT PAGE 4.10.10 LIFE PRESERVER

1. Draw the design of your successful life preserver. Tell the problems you had to overcome to make it work.

2. What makes this a technology project rather than a scientific inquiry?

ACTIVITY 4.10.11 CLAY

OBJECTIVES

The students
- Inspect samples of wet clay.
- Make clay snakes, dry them, and test them for resistance to breakage.
- Put dried mud in water and observe what happens.
- Bring in samples of what they believe to be clay.
- Use a shake jar to compare the relative amounts of sand, silt, and clay in their samples.

BACKGROUND

This activity is part of a sequence on soil started in grade 2 DASH. It should be done before Activity 4.10.12 FIRE AND POTTERY.

Clay and Its Makeup

Clays are made up of fine-grain rock particles smaller than a needle point 0.002 (1/500) millimeter or smaller in diameter. Clays are the finest parts of soils and mud, and they turn hard when dried.

Deposits of clays suitable for making pottery and brick are found in most parts of the world. Geologists or local potters will probably be able to locate deposits for you that are relatively sand- and silt-free. Sand is made up of rock particles with diameters from 2 millimeters down to 0.05 (1/20) millimeter. Silt is made up of rock particles larger than clay particles but smaller than sand particles.

Mud Samples

Samples of mud with clay content can be acquired
- On a field trip.
- By having the students bring in samples of what they believe to be clay.
- By bringing in your own samples from a place familiar to the students.

Separation of Clay

Clay can be separated from vegetable matter, rocks, sand, and silt by placing mud in a jar with plenty of water and shaking the contents until they are mixed. The mixture should be left to stand and settle. The clay will be the last layer to settle out from the mixture. Vegetable matter will float on the surface. See Figure 4.10.11.

Testing Clay

The suitability of clay for making pottery can be tested by shaping small globs into thin snakes and drying them. The best clay will be the most resistant to breakage when dry.

Drying clay in the sun often makes the clay crack because it dries faster on the outside than the inside. You may want the students to experiment to find ways to slow down the drying on the outside. One way is to wrap the clay loosely in plastic and another is to dry the clay in a cool place.

Notes

- In a shake jar larger clay particles settle at about 40 minutes per centimeter, so if your water in the shake jar is clear after one or two hours, you don't have much clay.
- Because clay particles can remain clumped even in a shake jar, the students may want to add small pebbles to the jar and shake it for several minutes to break the clumps before leaving the mixture to settle.

STUDENT ROLES

Geologist
Potter

MATERIALS

Potter's clay
Samples of clay (fine mud, preferably local brought in by the students)
Newspaper
Digging tools
Small baby food jars
Pint shake jars
Hand lenses
Student Page 4.10.11 CLAY

PRODUCTS

Pottery
Completed Student Pages

PROCEDURES

1. **Have the students cover their desks with newspaper and inspect samples of wet potter's clay.**

   Ask such questions as
   - What does it feel like?
   - What does it smell like?
   - Has anyone seen clay like this around here? Where?
   - Can you shape it into a test snake?
   - What happens to the snake when you try to bend it?
   - What happens to the snake when you leave it on your desk for awhile?
   - What do you think will happen to the snakes if you dry them?

2. **Have the students dry their snakes and inspect them after they dry. The snakes should be dry the next day.**

   Ask such questions as
   - Are there differences between the wet clay snakes and the dry ones?
   - What are the differences?
   - What do you think would happen if we put the snakes back into water?

3. **Have the students put the snakes back into water and inspect them the next day.**

   Ask such questions as
   - What seems to have happened to the clay?
   - How is it different from the original clay? How is it similar?
   - If you made tools out of wet clay and dried them, what could they be used for?
   - What couldn't they be used for?

4. **Have the students bring in samples of what they believe to be clay for study.**

   The samples should almost fill a baby food jar. You may want to arrange a class field trip for collecting samples or bring in samples yourself.

Ask such questions as

- How does this new sample compare with the sample from the other day?
- Does it feel the same?
- Does it smell the same?
- Is it as strong?
- How can you test this? (Set up the drying test.)
- What seems to be the chief differences in the samples? (If there are differences, work toward the idea of color, graininess, and so forth.)
- How might we compare the graininess?

5. **Introduce the use of a shake jar and have the students compare the relative amounts of sand, silt, and clay.**

   Demonstrate using the shake jar to test for clay.

6. **Have the students summarize the activity using Student Page 4.10.11 CLAY.**

   Ask such questions as

   - Where does the vegetable matter go in the shake jar?
   - Where does the large-grain material go? Why?
   - Where is the finest material?
   - Would your sample be a good source of clay?
   - How might you separate good working clay from your sample?
   - How might using the shake jar help explain why ,,it takes streams several days to lose their muddy color after a storm?
   - What is found below the fine mud on a mud flat?

7. **Have the students invent a way to separate clay from mud and test its qualities for making pottery.**

EXTENSION

- Have the students keep a list of places where clay is found in your area.

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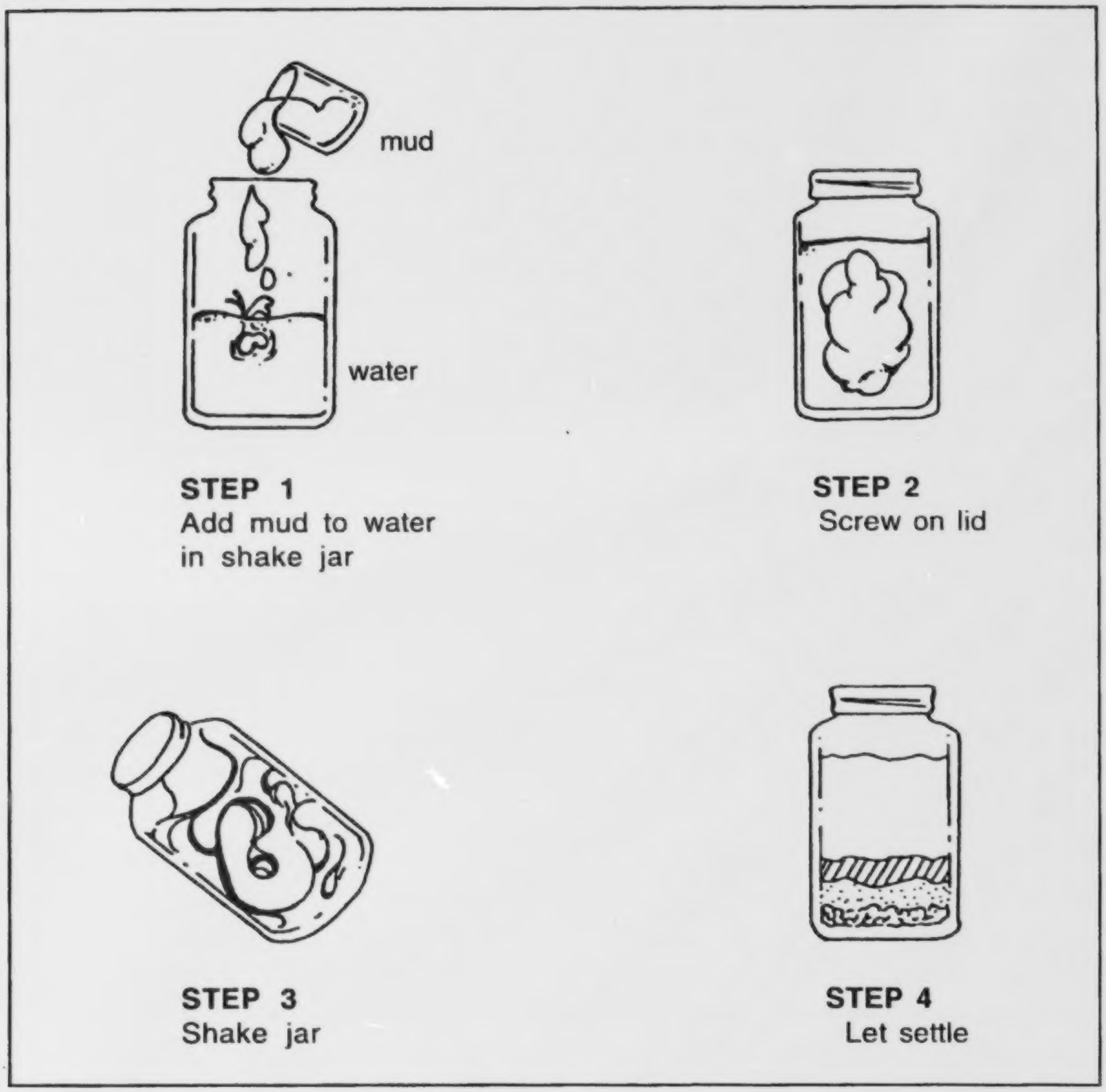

STEP 1
Add mud to water
in shake jar

STEP 2
Screw on lid

STEP 3
Shake jar

STEP 4
Let settle

Figure 4.2.11 Steps in working with a shake jar

DASH

Name__________________________

Date__________________________

STUDENT PAGE 4.10.11 CLAY

1. Describe wet clay.

2. Describe the clay snakes after they dried.

3. Describe what happened to the dried snakes when they were put into water.

4. What kinds of tools could be made from dried clay?

Name ______________________

5. Describe your clay sample before you put it into a shake jar.

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6. Draw the contents of your shake jar after settling. Indicate the thickness of each layer.

7. What fraction of your sample was sand? Silt? Clay?

Sand ________ Silt ________ Clay ________

ACTIVITY 4.10.12 FIRE AND POTTERY

OBJECTIVES

The students
- Make pottery bowls.
- Are introduced to a logic for firing clay.
- Fire their pottery.
- Test their fired pottery for strength and water resistance.
- Test to see whether anything is lost by the clay when it is heated.

BACKGROUND

This activity should be preceded by 4.6.4 SAFETY AND PUTTING OUT FIRES, 4.6.5 MAKING A FIRE, 4.6.6 THINGS THAT BURN and 4.10.11 CLAY. In FIRE AND POTTERY, the students begin to explore the role of high temperature in ancient and modern technology. In order to get durable pottery, it is necessary to fire clay objects. Heat drives out the water, and at high temperature it fuses some of the mineral content.

Preparing Pottery for Firing

Pottery pieces should be dried for a week or more before they are fired. If possible, have the students use a hibachi or barbecue grill for firing. Have them use charcoal as a fuel. See Figure 4.10.12. The pottery can be heated well enough within an hour to make it reasonably durable. A potter's kiln can be used as an alternative.

Firing Pottery

Allow fired pottery to cool by itself so that sudden changes in temperature do not break it. Place a metal bucket over the flaming charcoal in case any of the pottery pieces burst. This might happen if the clay has air pockets or is not sufficiently dry when fired. Eye shields should be worn.

Pottery firing should be done outdoors under strict supervision. Hair should be tied back from the face. A student safety monitor should be assigned to each student group working on the project.

Cone Numbers

If you wish to purchase clay for firing, look for a “cone” number on the package. The term cone refers to the temperature at which clay cures in a fire. Cone numbers range from 022, which cures at 600°C, to 17, which cures at 1480°C. In charcoal you can cure clays with a cone number up to about 06. This is a temperature of 980°C.

STUDENT ROLE

Potter

MATERIALS

Clay
Hibachi or barbecue grill
Metal bucket or tub with holes
Charcoal
Matches
Gloves
Eye shields or face guards
Charcoal starter
Balance
Student Page 4.10.12 FIRE AND POTTERY

PRODUCTS

Clay bowls
Completed Student Pages

PROCEDURES

1. **Introduce the activity by asking what kinds of things are made of pottery and listing them.**

2. **Have the students make a test snake and a small bowl that will hold water.**

   Have the students
   - Make their own bowl.
   - Make a small test snake.
   - Weigh the snake and record its weight.
   - Dry their bowl and test snake. (Dry clay slowly so that it does not crack. Keep it in a cool place or wrap it loosely in plastic.)
   - Determine whether there is any mass change in the snake while it dries by weighing it every day.

3. **Discuss what might account for the loss of mass in the clay as it dries and the need for firing clay.**

   Ask such questions as
   - What happened to the mass of the snake while it was drying?
   - What might be lost in drying? (Work to the idea of water.)
   - What would you predict would happen to your clay bowl if we tried to store water in it?
   - What happens to pottery in your home when you put water in it?
   - What is the difference between commercial pottery and your clay bowl?
   - Does anyone have any idea how we could make our clay bowl carry water without its turning back into a gooey mass?
   - The clay still contains a lot of water, how could we drive out the water? (Work to the idea of firing the clay.)

4. **Introduce the idea that very hot fire might drive off even more water.**

   Demonstrate how the clay pieces are to be stacked and covered with charcoal for firing.

   Have the students
   - Discuss safety. (Appoint a safety monitor.)
   - Light the fire and keep it going for at least an hour.
   - Place a metal cover over the charcoal in case the pottery bursts in firing.
   - Remove the clay pieces after the fire has burned itself out and the clay has cooled.

5. **Have the students measure to see whether the mass changed when the clay was heated. Have them report their results.**

   Ask such questions as
   - Was there any weight loss?
   - What do you think was lost?

6. **Have the students test the fired clay.**

   Have them
   - Try to break their test snakes without striking them.
   - Test the bowl with water.

7. **Summarize the activity with Student Page 4.10.13 FIRE AND POTTERY.**

Ask such questions as
- How did the strength of your fired snakes compare with that of your air-dried snake? (Normally the fired snakes are stronger.)
- How did the your fired pottery hold up when it was filled with water? (If pottery is adequately fired, it will not disintegrate.)
- Would you expect the air-dried clay to weigh more or less that the fired clay? Why? (Work to the idea that firing seems to drive off even more water.)

EXTENSIONS

- Have the students write a story about how someone could have discovered the secret of firing clay.
- Have a potter come in to demonstrate using a kiln and glazing pottery.
- Have the students prepare their own clay objects and glaze them.

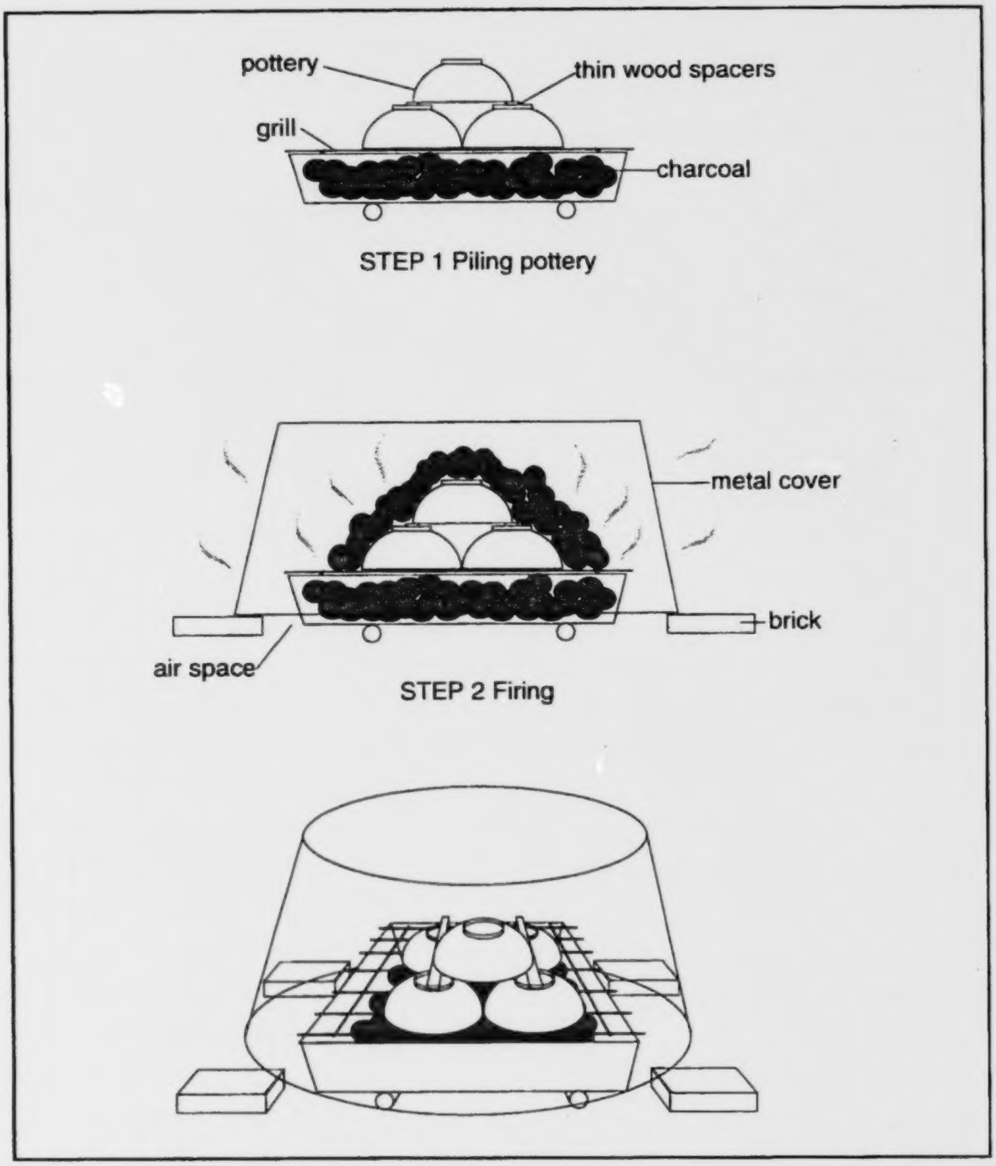
pottery
thin wood spacers
grill
charcoal
STEP 1 Piling pottery
metal cover
brick
air space
STEP 2 Firing

Figure 4.10.12 Using a charcoal burner to fire pottery

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.12 FIRE AND POTTERY

1. What kinds of things are made of pottery?

2. Describe how you made your clay vessel.

3. What was the mass of the bowl before sun-drying? ____

Drying? ________

After sundrying? ________

After firing? ________

4. What effect did the firing have on the clay?

ACTIVITY 4.10.13 AIR AND FIRE

OBJECTIVES

The students
- Burn a candle in an air-filled jar sealed off by water.
- Observe water rise in the jar when the candle burns.
- Interpret the rise of water level.

BACKGROUND

This activity is part of a series on the chemistry of air. It should come after Activity 4.6.4 SAFETY PUTTING OUT FIRES and should be closely followed by Activity 4.10.14 FIRE AND OXYGEN. In AIR AND FIRE the students explore the role of air in burning. They observe the classical covering of a candle standing in water within a jar. Water rises in the jar as the air is used in burning. The students may not immediately come to this conclusion. However, as they work further with burning things, they can return to this experiment. Demonstrate candle-handling techniques before the students undertake any exploring on their own.

It is suggested that all activities involving fire be done outside the classroom. Some students may not know how to strike a match to light a candle. Demonstrate and have them practice safe match-striking techniques. Emphasize how to
- Close the matchbook before lighting the match.
- Hold the match so that the fingers will not be burned.
- Shield the match so that wind does not blow it out.

Safety

When working with fire, the students should operate in teams with one member assigned the role of safety monitor. Hair should be tied back from the face and eye shields should be worn.

STUDENT ROLE

Chemist

MATERIALS

Birthday candles
Large glass baby food jars
Pie pans
Water
Matches
Plastic aquarium hose
Eye shields
Student Page 4.10.13 AIR AND FIRE

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Develop a concept map about the term "air."**

   Help the students include such things as
   - Air is a gas.
   - We breathe air.
   - We can capture air.
   - We can build with air.
   - Wind is moving air.
   - Air makes wind when it is heated or cooled.
   - Air must be present to have a fire.
   - Air will fill containers of any shape.

2. **Have the students hypothesize what happens to air around a fire.**

   Work for such ideas as
   - The air gets hot.
   - The air rises.
   - The air is used in burning.
   - The air is burned.
   - Nothing happens to the air.

3. **Explain that the class is going to explore the question of what happens to air when something burns. To do this we need to confine air while we watch burning. Demonstrate how to set up the equipment for the experiment. See Figure 4.10.13(1).**

   Ask such questions as
   - Why do we set the candle in water? (Get at the idea of sealing in the air.)
   - Why do we cover the burning candle with a jar? (Get at the need to confine the air.)
   - What would you expect to see if the air gets hot? (List all answers.)
   - What would you expect to see if air is used in burning? (List all answers.)
   - What would you expect to see if air burns? (Get at the idea that the jar might be filled with fire.)

4. **Have the students carry out the experiment. This may be done several times to verify observations. Have them record their observations and their interpretations on Student Page 4.10.13.**

5. **Have a student group summarize and record the class observations. Have another group lead a discussion of how the results of the experiment compare with the original hypotheses about what would happen to the air.**

6. **If the discussion does not result in a hypothesis for why water rises, probe further.**

   Ask such questions as
   - Is there as much air in the jar after the burning as before? How can you tell?
   - What could cause the water to rise?
   - How could we test to see whether some of the air has been removed, used, burned, and so forth?

7. **Have the students devise a demonstration to show that when air is removed from a jar of water, the water rises. (A piece of tubing inserted into a jar so that the air can be drawn into a syringe or lungs will work well.) See Figure 4.10.13(2).**

8. Return to a discussion of the students' original hypotheses.

Leave the students with such questions as

- Do you think all gases will allow a candle to burn in them? Put another way, do you think all gases support combustion? How could you find out?
- Do you think that there was some gas left in the jar after the candle went out? How could you find out?
- What questions do you have about the results of this experiment? (Have the students list their questions.)

EXTENSION

Demonstrate using a trick relighting birthday candle. Ask the students such questions as

- What happens to the candle after we blow it out? (It spontaneously relights.)
- If we put the candle into a jar, what happens to it after it goes out the first time? Why? (Because there is no oxygen, the candle will not relight.)
- What happens that is different when the candle is in the jar and when it is in the air?

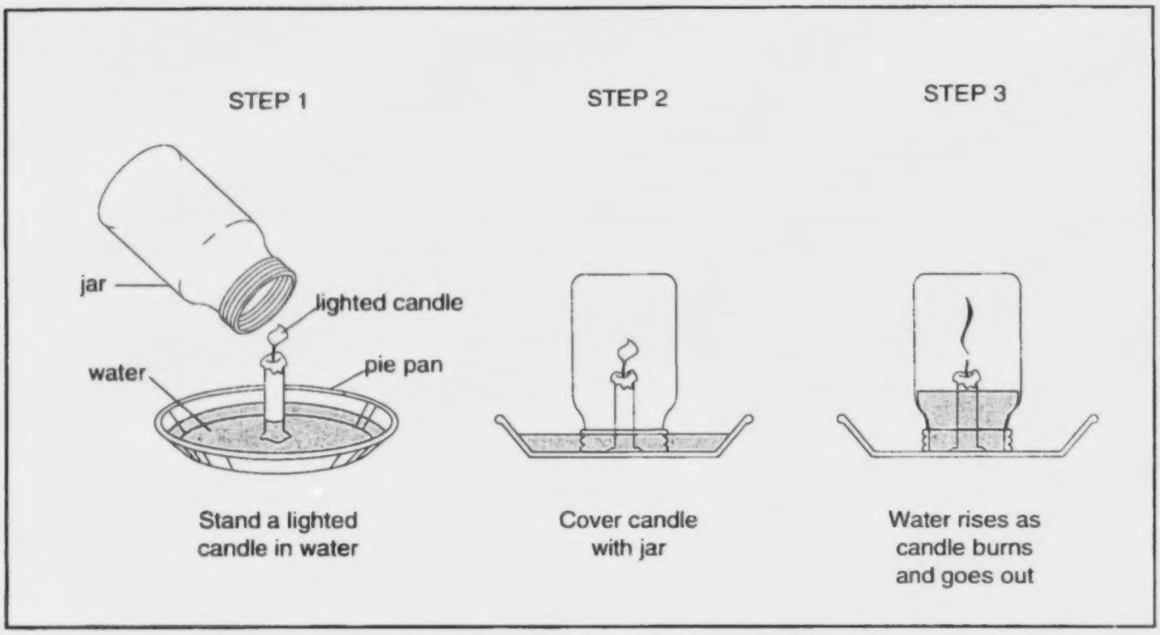
STEP 1
STEP 2
STEP 3
jar
lighted candle
water
pie pan
Stand a lighted candle in water
Cover candle with jar
Water rises as candle burns and goes out

Figure 4.10.13(1) Demonstration of a candle burning in air

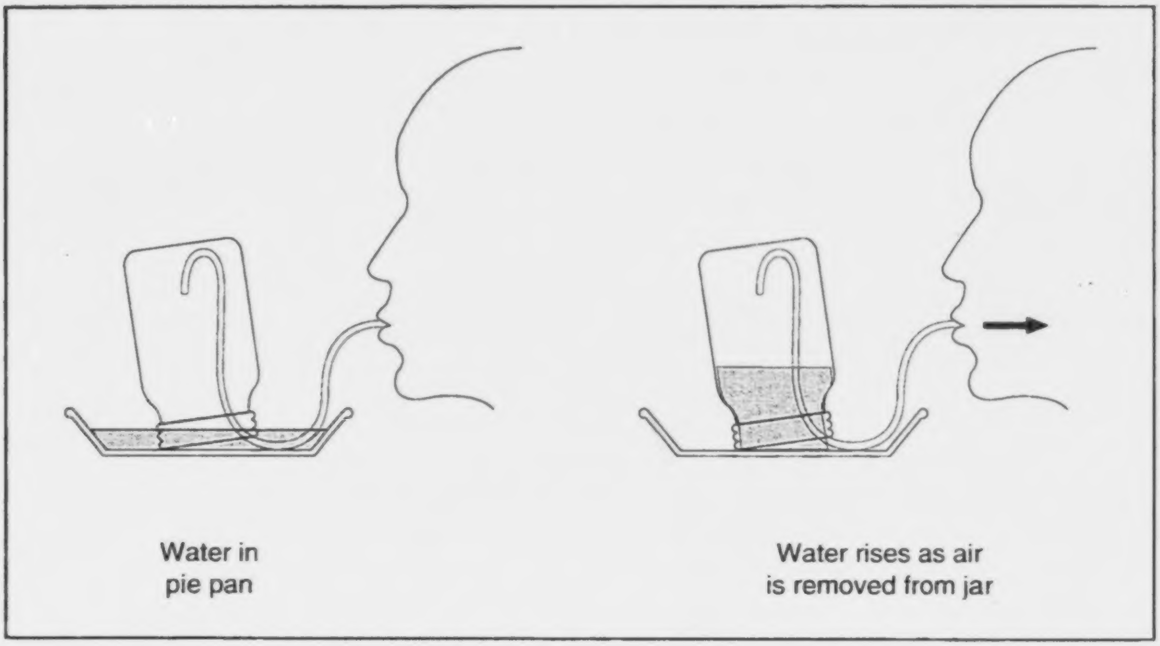
Water in pie pan
Water rises as air is removed from jar

Figure 4.10.13(2) Removing air causes water to rise

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.13 AIR AND FIRE

1. Draw and label the experimental equipment you used.

2. List your observations.

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3. List your conclusions.

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ACTIVITY 4.10.14 FIRE AND OXYGEN

OBJECTIVES

The students
- Experiment to determine whether all gases support combustion.
- Experiment to determine whether all gases are air.
- Generate oxygen and compare its properties with those of air.
- Collect gases over water.

BACKGROUND

This activity follows Activity 4.10.13 AIR AND FIRE and leads to Activity 4.10.15 PROPERTIES OF GASES. The students pursue the question of whether all gases support combustion. The students generate oxygen and compare its combustion properties with those of air and the gas left after burning a candle. They are left to explore what air might be and the nature of odors

Oxygen Production

Oxygen can be produced by putting manganese dioxide (MnO_2) in hydrogen peroxide (H_2O_2), the common hair bleach. See Figure 4.10.14(1). The reaction to release oxygen is **catalytic**, meaning that the manganese dioxide does not change in the reaction but simply speeds up the rate at which hydrogen peroxide decomposes into water and oxygen. Handle the solution of hydrogen peroxide using kitchen rubber gloves and wear an apron and eye protection.

Manganese Dioxide

If you have no manganese dioxide, it can be recovered from the gel of a D-battery. Break open a D-battery and scoop the gel into a container of water. Batteries can be opened with a hatchet or a pick hammer. The black manganese dioxide will settle out. Pour off the water. Magnesium dioxide can be used dry or wet. Test your generation system ahead of time to get a feel for the rate of oxygen generation. Three-percent hydrogen peroxide works slowly. A six-percent solution works faster. See Figure 4.10.14(1).

Safety

It is suggested that all activities involving fire be done outside the classroom or in a laboratory. Be sure hair is tied back from the face. Fire safety precautions should be emphasized. Since oxygen gas is quite reactive and may startle the students, you may wish to demonstrate the reactions of oxygen yourself. All teams should have a safety monitor.

Residual Gas

The term "residual gas" is used to describe the gas left behind after a candle burns in air. It is not a technical term.

STUDENT ROLE

Chemist

MATERIALS

Eye shields, aprons, rubber gloves
Plastic tubing (or plastic aquarium hose used in Activity 4.10.13 AIR AND FIRE)
Balloons or rubber sponge for stoppers
Birthday candles
Glass jars—baby food jars (large) or baby nursing bottles (small).
Pie pans
Water
Matches
Manganese dioxide
Hydrogen peroxide bottle
Sink or dishpan for gas transfer
Student Page 4.10.14 FIRE AND OXYGEN

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Develop a concept map and a working definition of the term "gas."**

   Help the students include such ideas as
   - There are many gases.
   - Air is a gas.
   - Other gases are like air.
   - "Gas" is also an abbreviation for gasoline.
   - A gas can take any shape.
   - A gas can be compressed.

- Gases include air, city gas (methane), butane, propane, oxygen, carbon dioxide and so forth.

2. **Get the students' thoughts on the question posed at the end of Activity 4.10.13 AIR AND FIRE: "Do you think all gases will allow a candle to burn in them?"**

   Ask such questions as
   - Put another way, do you think all gases support combustion? How could you find out? (Explore the notion that we can test other gases to see whether a candle will burn in them.)
   - Do you think that there was some gas left in the jar after the candle went out? How could you find out?
   - What evidence would we look for to tell us that there is still gas in the jar? (Get at such things as it would make bubbles if poured out under water, we could draw it out with a syringe, and we could feel it as it is pushed out of the syringe.)
   - If there were a gas remaining in the jar, do you think it would still support combustion when transferred to another container?

3. **Have the students predict whether a gas will still be in the container after the candle goes out and, if so, whether a candle will burn in the gas.**

   Have the students
   - Invent a test to see whether there is still gas in the container after the candle goes out.
   - Try to devise a way to transfer to another smaller container any contents remaining in a jar after a candle has burned out. (Their method should fill a second smaller container with the residual contents. Cover the mouth of the container with a lid. See Figure 4.10.14(1) for a technique to transfer gases under water.)
   - Collect a bottleful of the residual gas.
   - Put a candle into the mouth of the bottle and test to see whether the candle burns. (If no outside air gets into the bottle, the candle should go out.)

4. **Summarize the investigation.**

   Ask such questions as
   - How did you test for the presence of a gas after the candle went out?
   - Was there a gas left in the bottle? What was your evidence?

- Does a candle burn in our residual gas? (Work to agreement that it does not.)
- If air burns, what should happen when we light a match in it and then remove the match? (Get at the idea that if air burns, it will continue to burn once a fire source is removed just as a candle burns once the match that lit it is removed.)
- If we add outside air to residual gas in the jar and then put a candle in the jar, what do you predict will happen? (Have the students test their answers. Air and residual gas can be transferred to a third container underwater.)
- What would happen if we pull the candle out of the jar into the air before the candle goes out?
- What will happen if we put the candle back in? (Test by pulling the candle in and out until it stops burning. Move the candle slowly so that fresh air is not stirred into the residual gas.)
- Why do you think the candle went out? (Get at the idea that only residual gas is left.)
- Does air burn? (No. Work toward the idea that it only lets things burn in it. If it burned, the jar would be filled with fire, and the fire would continue when the candle is removed.)
- Does the residual gas support combustion or let things burn in it? (Work to the logic that the gas puts out the candle; therefore, it must not support combustion.)
- Does air support combustion? (Help the students see that because the candle burns in air, it must support combustion.)
- Is the residual gas the same or different from air? (Work to the logic that because air supports combustion and residual gas does not, residual gas is different from air.)
- Allow the students to explore with air and residual gas.

5. **Tell the students that the French researcher Antoine Lavoisier investigated a gas that he called “oxygen.” He found that it had several properties similar to those of pure air. We can produce oxygen by putting a little manganese dioxide into hydrogen peroxide.**

Ask such questions as

- If oxygen is like air, what might this mean? (Get at such ideas as it supports combustion, does not burn, and is colorless.)
- What experiments could we perform to see what Lavoisier meant when he said oxygen is like pure air? (Work to the idea of seeing whether it supports combustion, does not burn, and is colorless.)

6. Demonstrate how to generate oxygen. See Figure 4.10.14(1).

7. Demonstrate how to test for oxygen. See Figure 4.10.14(2).

Carry out the following steps

- Thrust a glowing (not flaming) broom straw into oxygen. (Light a broom straw, blow it out, but keep it glowing. When thrust into oxygen it will burst into flame. In air it will simply continue the glow.)
- Heat a small piece of steel wool in a candle flame till it glows then drop it into a container of oxygen. (If it is hot enough, it will burst into flame. Be prepared for students to be startled.)
- Try to burn oxygen by passing a candle in and out of a bottle. (Engage the students in a discussion of whether oxygen burns. Oxygen does not burn when we pass a flame in front of it. Oxygen does not continue to burn when a flame is removed from it. Conclusion, oxygen supports combustion but does not burn.)

8. Summarize the work. Have the students use Student Page 4.10.14 FIRE AND OXYGEN.

Ask such questions as

- How is oxygen like air?
- Does oxygen appear to be different from air? (Work for the idea that the same things happen in oxygen and air, but in oxygen the reaction is more intense.)
- What are some of the properties of oxygen? (Get at the observation that it supports combustion.)
- What did Lavoisier mean when he said oxygen is like pure air?

9. Introduce some questions to think about.

- What might pure air be? (This an exploration questions. The students may make a synthetic air of oxygen and residual or other gases.)
- Does air carry odors? (Give such examples as when we walk into a house, when the gas in the stove is turned on, when we open the refrigerator, when we pass gas, and so forth.)
- Where do the odors come from? (List odor sources—perfumes, flowers, foods, dead things, and so forth.)
- Does air that is not near these odor sources smell? (The students can test this. Pure air normally does not smell.)

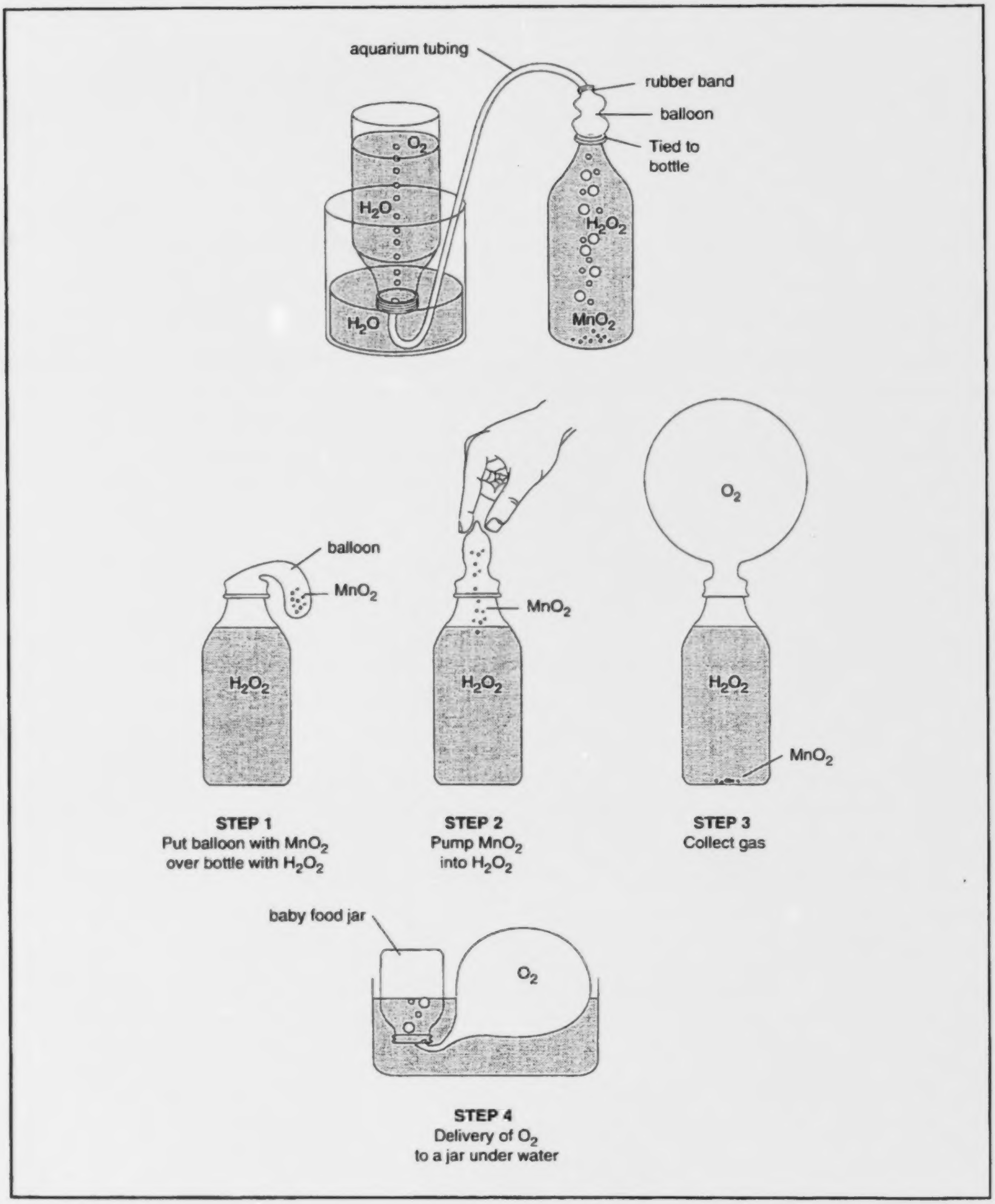
- Does oxygen have an odor? (Logic would dictate that oxygen does not have odor. If oxygen is one of the gases in pure air and air has no odor, then oxygen has no odor.)
- Can air be poisonous? (Pursue the idea that pure air cannot be poisonous or we could not breathe it.)
- Where do poisonous gases come from? (Work to the logic that they must be put into the air. For example, stove gas is poisonous [it comes from a gas jet]; automobile exhaust is poisonous [it comes from the exhaust of cars]; gasoline fumes are poisonous [they come from a gas tank].)
- Is oxygen poisonous? (Again this is a process of logic. If oxygen were poisonous to us, we could not breathe air because this gas is in air. However, the students will find on researching the subject that oxygen must be diluted to keep it from damaging our bodies.)

EXTENSIONS

- Have the students report on the history of the discovery of oxygen. People involved were K.W. Scheele (1773), Joseph Priestly (1774), and Antoine Lavoisier (1775).
- Have the students do library research to find what other gases make up air. (They will find the principal gas to be **nitrogen**, which made up most of the residual gas in the oxygen experiments. The next most abundant gas is **oxygen.** Next is **water vapor,** which will vary in amount according to the humidity. Argon, carbon dioxide, and other gases are found in very small amounts. In a dry sample of air the percentages or parts per 100 of the gases are about

78.08%	Nitrogen
20.95%	Oxygen
00.93%	Argon
00.03%	Carbon dioxide
00.01%	Other

- Have the students do library research on poisonous gases and report their findings to the class.


aquarium tubing
rubber band
balloon
Tied to bottle
O_2
H_2O
H_2O
H_2O_2
MnO_2
balloon
MnO_2
H_2O_2
MnO_2
H_2O_2
O_2
H_2O_2
MnO_2
baby food jar
O_2

STEP 1
Put balloon with MnO_2 over bottle with H_2O_2

STEP 2
Pump MnO_2 into H_2O_2

STEP 3
Collect gas

STEP 4
Delivery of O_2 to a jar under water

Figure 4.10.14(1) Ways to generate oxygen using hydrogen peroxide (H_2O_2) and the catalyst manganese dioxide (MnO_2)

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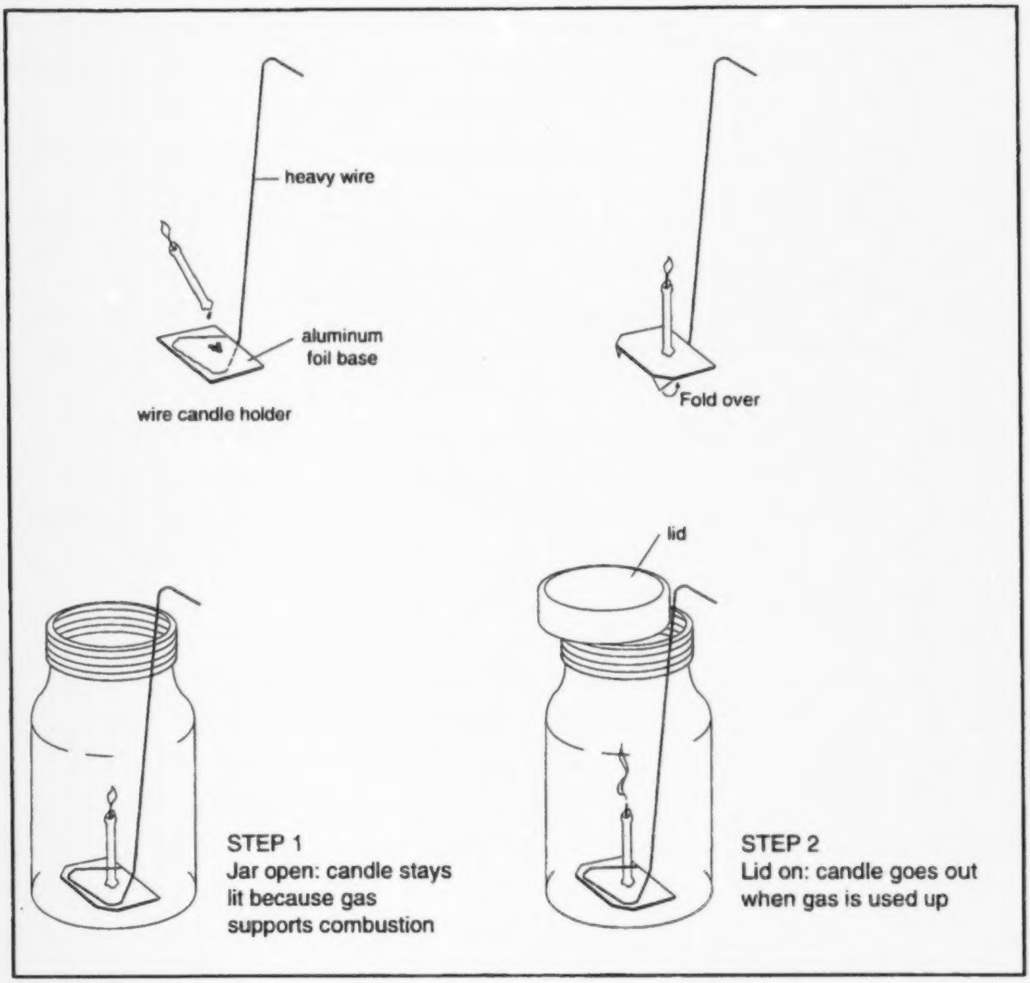
heavy wire
aluminum foil base
wire candle holder
Fold over
lid
STEP 1
Jar open: candle stays lit because gas supports combustion
STEP 2
Lid on: candle goes out when gas is used up

Figure 4.10.14(2) Steps in testing for oxygen

Name________________________

Date________________________

STUDENT PAGE 4.10.14 FIRE AND OXYGEN

1. Draw and label the equipment used to generate oxygen.

2. List your observations of the residual gas.

____

____

____

____

3. List your observations of oxygen.

____

____

____

____

ACTIVITY 4.10.15 PROPERTIES OF GASES

OBJECTIVES

The students
- List sources of gases.
- Explore the properties of carbon dioxide
- Contrast carbon dioxide with gases previously investigated.

BACKGROUND

This activity is a companion to Activity 4.10.13 AIR AND FIRE and 4.10.14 FIRE AND OXYGEN. The students test for properties of other gases, focusing on carbon dioxide (CO_2) and then identify an unknown gas. PROPERTIES OF GASES in turn leads to Activity 4.6.7 SMOKING AND THE LUNGS.

It is **not** recommended that a gas testing station be set up in the classroom. Any gases other than the ones suggested here should be tested only by you. **Do not test any gas that you do not know about.**

Limewater

Make limewater by pouring two tablespoons of commercial builder's lime, or calcium hydroxide, $Ca(OH)_2$, into a quart jar of water. Put a lid on the jar and shake the contents. Allow the solution to stand or settle for an hour before using. Over several days a scum may appear on the surface. This can be removed with a paper towel.

Unknown Gas

Use carbon dioxide as the unknown gas. Carbon dioxide can be generated several ways:
- Put Alka-Seltzer in water.
- Drop a small piece of dry ice into water.
- Make a gas generator similar to the one shown in Figure 4.10.15. Pour in 10 mL of vinegar (acetic acid [$HC_2H_3O_2$] and a teaspoon of baking soda (sodium bicarbonate [$NaHCO_3$]).

Safety

When dealing with fire, work should be done outdoors under strict supervision. Hair should be tied away from the face. Each team should have a safety monitor.

STUDENT ROLE

Chemist

MATERIALS

Eye shields
Half-liter plastic bottles for generating carbon dioxide
Plastic tubing
Balloons or rubber sponge for stoppers
Candles
Glass jars
Pie pans
Dishpans in which to generate and transfer gas
Water
Matches
Alka-Seltzer
Dry ice
Baking soda (sodium bicarbonate [$NaHCO_3$])
Vinegar (acetic acid [$HC_2H_3O_2$])
Hydrion pH test strips for testing acid
Powdered lime (commercial builder's lime)
Student Page 4.10.15 PROPERTIES OF GASES

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Have the students list sources of gases. If the students have not included Alka-Seltzer, add it to the list.**

2. **Demonstrate how to test some characteristics of the gas carbon dioxide (CO_2) produced by Alka-Seltzer reacting with water.**

A successful demonstration can be carried out in the following way:
- Capture some CO_2 in a baby food jar.
- Add several milliliters of limewater to the jar with CO_2. Put on the lid and shake the contents. (A precipitate will form. Repeat with air. No appreciable precipitate will form.)
- Add several milliliters of tap water to another sample of CO_2, put a lid on the jar, shake the contents, and test the pH using Hydrion strips. (The paper will register below 7 in the acid range. Repeat with acid. The pH will remain about 7.)
- Check the odor of the CO_2 by waving a hand over the gas container and smelling very tentatively. (Point out the need to test gases very carefully because some may be poisonous. Carbon dioxide, like air and oxygen, is odorless. Note that gases are described by odor and color.)
- Check the flammability of CO_2 by putting a lighted candle into a sample. (The candle should go out, indicating that carbon dioxide is non-flammable.)

3. Summarize the investigation.

Ask such questions as
- What are the properties of carbon dioxide gas? (Get at such things as it is not flammable, does not support combustion, is colorless and odorless, forms a precipitate with limewater, and in solution tests acid.)
- How is carbon dioxide different from oxygen? (Work for such things as oxygen supports combustion while carbon dioxide does not. Air does not form a precipitate with limewater and when mixed into water does not lower the pH. Oxygen makes up about 20% of the air and acts much the way air acts.)

4. Have the students generate an "unknown" gas and test it to see whether its properties more closely resemble oxygen or carbon dioxide.

Have the students
- Use safety precautions when using cold materials.
- Generate an unknown gas by placing small pieces of dry ice in water. (As an alternative use baking soda ($NaHCO_3$) and 10 mL of acetic acid.)
- Capture the gas.
- Test the gas.

5. **Summarize how the unknown was identified. Have the students complete Student Page 4.10.15 PROPERTIES OF GASES.**

   Ask such questions as
   - What gas was the unknown like?
   - What is your evidence?

EXTENSION

- Have the students read and report on the discovery of carbon dioxide.

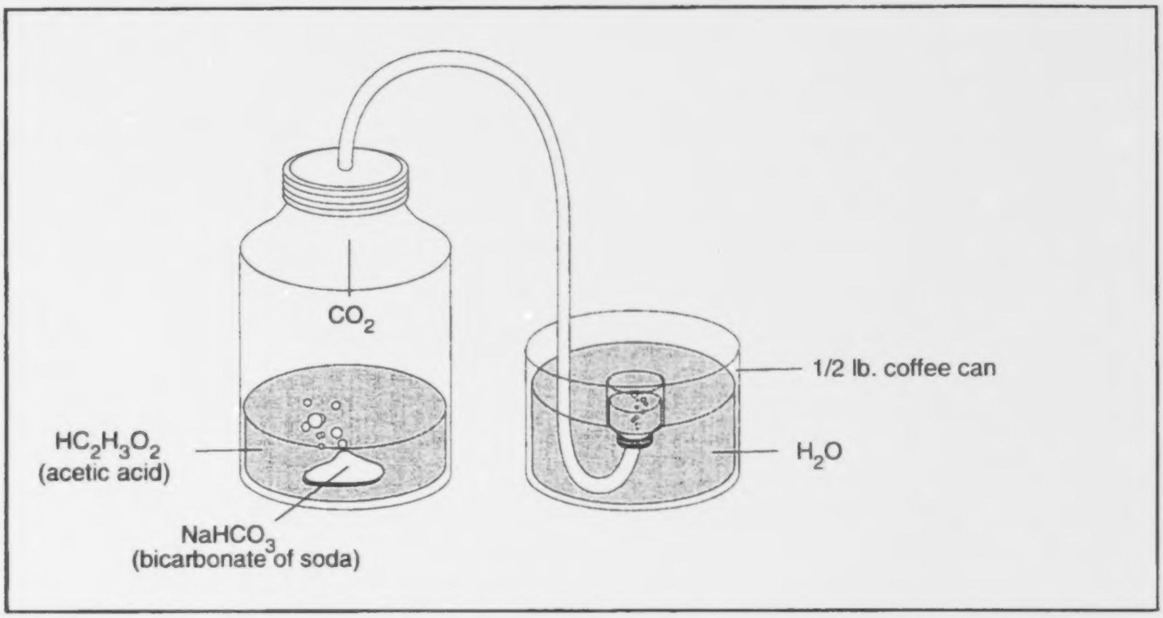
CO_2
1/2 lb. coffee can
$HC_2H_3O_2$
(acetic acid)
H_2O
$NaHCO_3$
(bicarbonate of soda)

Figure 4.10.15 Device to generate carbon dioxide (CO_2) using baking soda (sodium bicarbonate [$NaHCO_3$]) and vinegar (acetic acid [$HC_2H_3O_2$])

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.15 PROPERTIES OF GASES

1. Describe your testing of gases.

2. What was your "unknown" gas? ______________

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.1 LINEAR MEASUREMENT

1. Describe how you subdivided your paper-tape copy of a meter into decimeters, centimeters, and millimeters.

2. Describe how you made your meter-string can.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.2 VOLUME MEASUREMENT

1. Describe how you calibrated a 500-mL container.

2. Describe how you calibrated a 50-mL interval in 10-mL increments.

3. Describe how you calibrated your 20-mL graduated cylinder in 2-mL increments.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.3 MASS MEASUREMENT

1. Draw your balance and tell how it works.

2. Explain how you made your counterbalance.

Name________________________

Date________________________

DASH

STUDENT PAGE 4.10.4 COLLECTING ROCKS

1. List the records we will keep on the rocks we collect.

____

____

____

2. List differences in rocks found a) in a streambed, b) in a larger rock mass, and c) in soil some distance from a streambed or large rock mass.

____

____

____

3. List the permanent properties you used to identify rocks.

____

____

____

4. Show the master dichotomous key you used to identify all of the rocks.

Name______________________

Date______________________

STUDENT PAGE 4.10.5 HARDNESS OF ROCKS

1. Develop a working definition for a scale of hardness.

2. Use a class scale of hardness based on Mohs ratings. List rocks and other materials in their order of hardness.

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.6 SPECIFIC GRAVITY

1. Give your working definition of specific gravity.

____

____

2. What is the rule relating the volume of an object to the volume of water it displaces?

____

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____

____

3. Use diagrams to describe a way to find the specific gravity of a rock.

Name ______________________

4. Make a table and record your data on the specific gravity of rocks.

	A	B	C
Mass of rock			
Volume of rock and water			
Volume of water			
Volume of rock			
Mass of water			
Mass of water equal to volume of the rock			
Specific gravity of rock			

5. A student got the following data when finding the specific gravity of some rocks. Complete the table.

	A	B	C
Mass of rock	50 g	25 g	75 g
Volume of rock and water	35 mL	35 mL	80 mL
Volume of water	10 mL	30 mL	55 mL
Volume of rock			
Mass of water			
Mass of water equal to volume of the rock			
Specific gravity of rock			

Name ______________________

In Procedure 5

6. Which rock weighs the least? __

7. Which rock has the least volume? __

8. Which rock or rocks have the greatest volume? __

9. Which rock has the greatest specific gravity? __

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.7 ROCKS AND SHARP EDGES

1. What is your working definition of the term "sharpness"?

2. What is your working definition of the term "durability"?

3. Describe your sharpness scale.

4. Describe how you rated durability.

945

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.8 MAKING TOOLS FROM ROCK

1. **Describe or draw the tools you have decided to make and tell why you chose to make these particular tools.**

2. **List your tools and the time required to make them.**

Tool	Time Required

3. **Explain how you tested your tools.**

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.9 MAKING FISHING TOOLS

1. Draw a diagram of the tool you made and tell how it is intended to work.

2. Describe how successful your tool was in catching fish. Why was this so?

Name ____________________________

3. How did the materials you chose help shape the way you thought about the way you could make your tool?

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4. How long did it take to make your tool? __________

5. What are the advantages and disadvantages of using natural materials to make fishing tools?

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Name________________________

Date________________________

DASH

STUDENT PAGE 4.10.10 LIFE PRESERVER

1. Draw the design of your successful life preserver. Tell the problems you had to overcome to make it work.

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2. What makes this a technology project rather than a scientific inquiry?

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Name____________________________

Date_____________________________

DASH

STUDENT PAGE 4.10.11 CLAY

1. Describe wet clay.

2. Describe the clay snakes after they dried.

3. Describe what happened to the dried snakes when they were put into water.

4. What kinds of tools could be made from dried clay?

Name ______________________

5. **Describe your clay sample before you put it into a shake jar.**

____

____

____

____

6. **Draw the contents of your shake jar after settling. Indicate the thickness of each layer.**

7. **What fraction of your sample was sand? Silt? Clay?**

Sand ☐ **Silt** ☐ **Clay** ☐

DASH

Name______________________

Date______________________

STUDENT PAGE 4.10.12 FIRE AND POTTERY

1. What kinds of things are made of pottery?

2. Describe how you made your clay vessel.

3. What was the mass of the bowl before sun-drying? ____

   Drying? _______

   After sundrying? _______

   After firing? _______

4. What effect did the firing have on the clay?

DASH

Name________________________

Date________________________

STUDENT PAGE 4.10.13 AIR AND FIRE

1. Draw and label the experimental equipment you used.

2. List your observations.

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3. List your conclusions.

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Name________________________

Date________________________

STUDENT PAGE 4.10.14 FIRE AND OXYGEN

1. Draw and label the equipment used to generate oxygen.

2. List your observations of the residual gas.

3. List your observations of oxygen.

Name________________________

Date________________________

STUDENT PAGE 4.10.15 PROPERTIES OF GASES

1. Describe your testing of gases.

2. What was your "unknown" gas? ______________

DASH

GRADE 4

SUPPORT MATERIALS

DASH

GRADE 4

START-UP ACTIVITIES & STUDENT PAGES

DASH

GRADE 4
START-UP ACTIVITIES

SU.1	Classification
SU.2	Working Definitions
SU.3	Living and Not Living
3.1.4	Planning
3.1.5	Organization
1.2.8	Night and Day
2.2.7	Digital Time
2.2.8	Analog Time
K.2.7	Moon Phases
3.2.7	Moon Phases
3.2.8	Polar Sky Model
3.2.9	Polar Constellation
3.2.11	Eclipses
2.4.1	Soil
2.4.2	Making Soil
2.4.3	Soil and Plants
2.4.4	Soil Uses
2.4.5	Finding Soil
3.4.13	Flowers
3.3.7	Frog Metamorphosis
3.5.1	Food Selection
3.10.2	Acids and Bases
3.10.3	Acid and Base Reactions

SU.1 CLASSIFICATION

OBJECTIVES

The students
- Use their senses to describe selected objects.
- Identify the different senses used in collecting the information.
- Relate physical properties of things to senses.
- Classify a collection of items according to their similarities and differences.
- Are introduced to two category classification or dichotomous classification.
- Classify objects by their physical properties.
- Identify both similarities and differences in functions of items.
- Classify items by their functions.

BACKGROUND

This start-up activity is designed to introduce students new to DASH to the fundamental science concept and skill of classification. The teacher will need to adapt and modify the suggested procedures depending on the previous experience and developmental level of the students.

Senses and properties

The students first make a concept map about the senses of sight, hearing, touch, smell, and taste. They associate these senses with their sensing organs—eyes, ears, skin, nose, and tongue and identify the properties of objects that can be sensed—color, sound, texture, temperature, odor, flavor, and so forth.

Same and Different game

The students next play the Same and Different game in which they sort items into six or more different major categories. Each major category is made up of some set of common classroom items such as paper clips, books, pencils and so forth. Objects in a category have the same form and function. The *form* of an object refers to its physical properties, what it is made of, and its parts and their organization. The *function* of an objects refers to what it does or is used for.

Kinds of things or categories

The teacher and students work together to create category names such as pencils, rulers, paper clips and so forth as two or three

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different kinds of things or items are drawn from a container holding a Master Collection. The students then match other items with existing categories or create new categories when different kinds of items are presented. The students can also invent logos to represent each category—example, a picture of a pencil or a ruler.

Building a Master Collection

Most of the procedures in this activity use a master collection of items. It needs to be large enough so there is at least one item per student. Needed for the master collection are 6 or more major categories, each with two subcategories. One of the two subcategories has items that all look the *same*. The other subcategory has the same kind of items but they look *different* from all other items. For example, the major category pencils could have a *same* pencils subcategory—two brand new white pencils and a *different* pencils subcategory —four to eight used, different colored pencils. See Figure SU.1(1) for some suggestions for a master collection.

Category: Pencils Subcategories: 2 New pencils that look the same. 4-8 Used pencils, each different from all other pencils. (e.g. different colors, lengths)	Category: Paper Clips Subcategories: 2 New paper clips that look the same. 4-8 Paper clips, each different from all other paper clips (e.g. different colors, sizes)
Category: Books Subcategories: 2 New books that have the same title. 4-8 Used books, each with a different title.	Category: Rulers Subcategories: 2 New rulers that look the same. 4-8 Used rulers, each different from all other rulers (e.g., different colors, materials)
Category: Paper Subcategories: 2 New sheets of paper that look the same. 4-8 Used sheets of paper, each different from all other sheets of paper. (e.g. different colors, sizes)	Category: Crayons Subcategories: 2 New crayons that look the same and have the same color. 4-8 Used crayons, each different from all other crayons. (e.g. different colors, lengths)

Figure SU.1(1) Six possible categories of game items for a master collection.

Physical properties and two category classification

Next the students use the physical properties of size, shape, and other visual and tactical characteristics to separate items into subcategories.

To do this they are first introduced to a two category or dichotomous system for sorting or classifying items. Scientists use a simple two category or dichotomous system to sort or classify things. They take a collection of items, inspect it, and divide the collection into two different categories. One category has a distinct characteristic and the other does not have that characteristic.

Name Game

To get a feeling for the dichotomous classification system, start with the Name Game. Select four or five students and group them in the inclusive category *All Students*. For example, *All Students* might be Jan, Jack, Jill, Jo, and Jim. Then divide *All Students* into two categories—*Jan* and *Not Jan*. Next divide *Not Jan* into two more categories—*Jill* and *Not Jill*. Continue the process until *Jo, Jack* and *Jim* have their own separate categories. See Fig. SU.1(2).

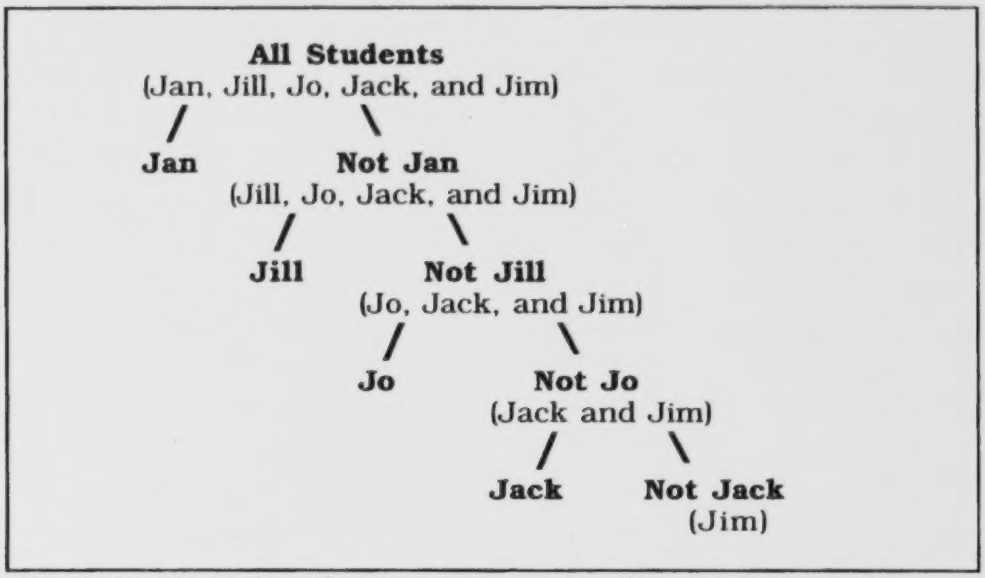

Fig. SU.1(2) A classification tree sorting five students in the Name Game using a two category or dichotomous system.

Classification game

Use the items from the Master Collection for the classification game. Have the students classify the objects by their physical properties or *forms*. First the students work with the teacher on one of the major categories such as pencils. Together they successively divide the items in the major category into pairs of sub-categories using differentiating physical properties. After the students have worked through classification of one major category, have them work in small groups to classify other major categories.

Follow the process used in the Name Game. On a table or the floor put all of the items in a single major category. *All pencils* are shown in the example in Fig. SU.1(3). The first two subcategories of *All Pencils* are *White pencils* and *Not white pencils*. Then the *Not white pencils* are divided into two subcategories—*Yellow pencils* and *Not yellow pencils*. Again the division continues until the items can no longer be separated. Here the pencils were separated by the physical property of color. Multiple physical properties such as color and length, can be used within the same category classification as desired.

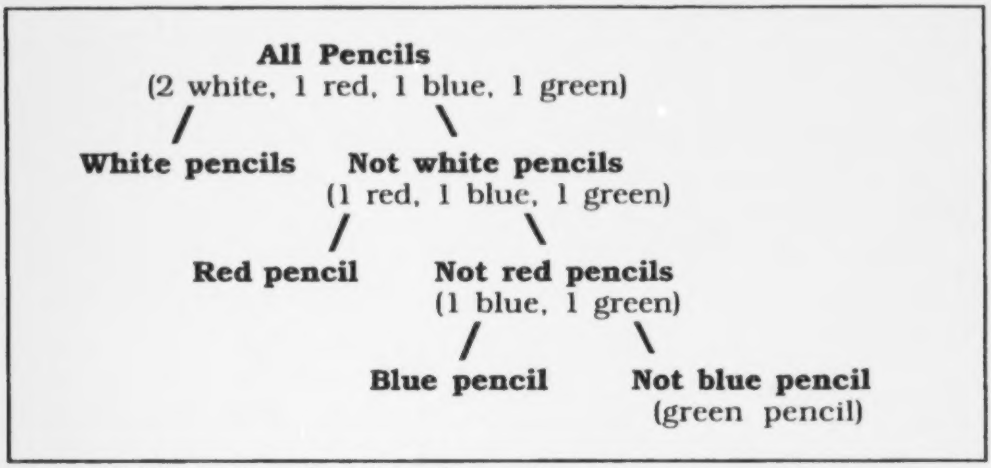

Fig. SU.1(3) Classification of pencils using a two category or dichotomous system and a classification tree.

Showing steps in the classification
The students are then asked to help draw a diagram showing the steps they went through to identify different objects as in Figures. SU.1(1–2). This creates a *classification tree* by connecting the words or boxes with lines to show the division of categories. The students record their categorization on a class chart. Then they work in small groups to classify other major categories and record their work on SP SU.1 CLASSIFICATION TREE.

Function classification game
Next the students are introduced to classification by *function*. First they work with the teacher to classify items and to get an idea of the meaning of the function of a thing or what it does or is used for. Then they work in small groups to classify sets of items by function.

Function game
The function game is played with one item from each of four of the major categories from the master collection. These are put on the table and the students find a functional category name that will fit them all. For example, for a collection of a pencil, ruler, crayons, and a piece of paper, the functional category could be *Things used in drawing*

or *Classroom tools*. The students then classify the set into a pair of function subcategories labeling the function of one item and labeling the other as not having that function. For example; *Thing used in measuring* (ruler) and *Things not used in measuring* (all other items). Words or logos are used to identify the function categories. Figure SU.1(4) shows some possible functions for items in the master collection. With the teacher, the students separate the remaining three items into functional subcategories. For example: *Things used to write on* (paper) and *Things not used to write on* (crayons and pencils). See Figure SU.1(5).

Item	**Possible Function**
Book	Items used to read, to hold printed words and pictures, to press flowers, etc.
Crayon	Items used to color paper, to batik, to color candles, etc.
Paper	Items used to write on, to make airplanes or spitballs, etc.
Paper clip	Items used to hold papers together, to release computer disks, etc.
Pencil	Items used to write on paper, to poke holes, to hold doors open, etc.
Ruler	Items used to measure distance, to draw straight lines, to make ramps for marbles, etc.

Figure SU.1(4) A list of some possible functions for the master collection.

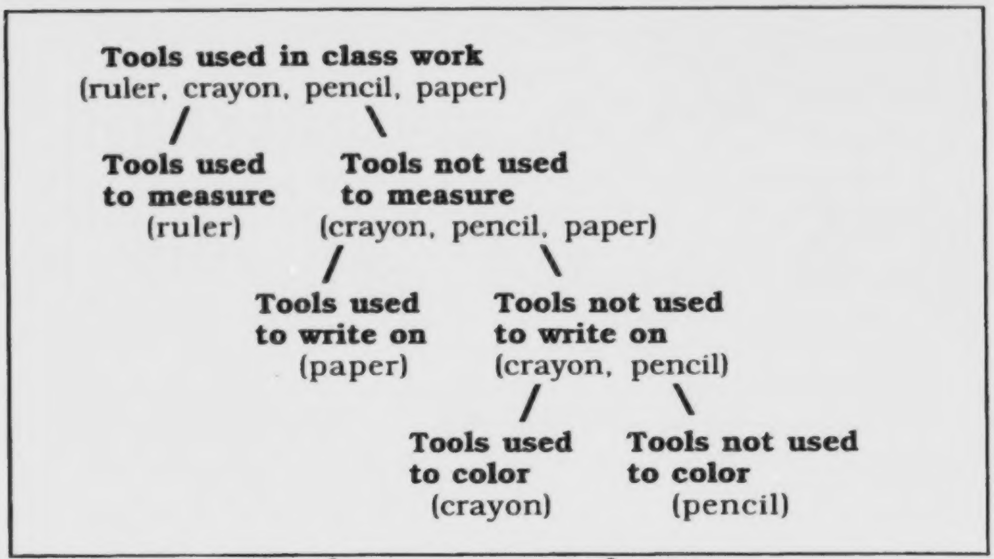
Tools used in class work
(ruler, crayon, pencil, paper)
Tools used to measure
(ruler)
Tools not used to measure
(crayon, pencil, paper)
Tools used to write on
(paper)
Tools not used to write on
(crayon, pencil)
Tools used to color
(crayon)
Tools not used to color
(pencil)

Fig. SU.1(5) A classification tree using function.

STUDENT ROLES

Observer
Classifier
Taxonomist

MATERIALS

chart paper
markers
items for the master collection
Student Page SU.1 CLASSIFICATION TREE

PRODUCTS

Class charts of classification using form and function
Completed Student Pages

PROCEDURES

1. **Have the students construct a concept map about physical properties and the senses.**

   Help them to include such ideas as these by asking questions about

- The sense of sight.
  ✔ Work to the idea that the eyes provide the sense of sight.
  ✔ Include sight associated physical properties such as color, size, shape, pattern and so forth.

- The sense of hearing.
  ✔ Work to the idea that you hear things with your ears.
  ✔ Include hearing associated physical properties such as pitch (high/low), intensity or amount (soft/loud/painful), beat (fast/slow), and so forth.

- The sense of touch.
  ✔ Work to the idea that you feel things with the skin.
  ✔ Include touch associated physical properties such as feeling texture (rough/smooth, soft/hard, sharp/dull, others), pressure (heavy/light/pain), temperature (hot/cold), and so forth.

- The sense of smell.
  ✔ Work to the idea that you smell things with the nose.
  ✔ Smells are described as being like something known–like fruit, perfume, or foul odors.

- The sense of taste.
  ✔ Work to the idea that you taste things with the tongue.
  ✔ Include touch associated physical properties such as sweet, sour, bitter, and salty.
  ✔ CAUTION: Remind students that it is dangerous to taste things that are not foods.

2. **Introduce the Same and Different game using items from the master collection. See Background. Keep items in a container so that they are seen only when pulled out. Have the students focus on the major category names (pencils, paper clips, paper, and so forth). Do not worry about subcategory differences at this time.**

   - Pull an item from the container and ask the students to give it a name.
     ✔ Ask, What is this? or what do we call this? The name they suggest will usually tell what kind of thing the item is and be its category name.

   - Draw a box or circle on chart paper and put the item in it. Label the box with the category name.

   - Show the students another item and ask them if it is the same or different from the one already out in the circle or box.

- If different, draw and place it in a different box or circle. Label the box with the new category name.
  ✔ Start using the term *category* to describe the box or circle and the items in it.

- If it is the same, place it in the box with the similar object.
  ✔ Start using the term *category* to describe the box or circle and the items in it.

- Ask why they put the item where they did?
  ✔ Usually students will say they look alike or do the same things.

- Ask why they didn't put the items in some other category?

- Continue until the students are reasonably fluent with the ideas of same, different, and category.

- Summarize the activity by asking what they mean when they say something is in a *category*. Ask them to give examples of categories and things that could be included in them.
  ✔ Work to such things as new, old, and used pencils are in the category pencils; new, old, and beat-up cars are all in the category cars. In each case members of the category share some properties and do the same thing.

- Help the students to understand the importance of knowing about physical properties by asking them how they tell one object from another.
  ✔ Work to describing the physical properties of the objects.

3. **Introduce the students to playing a Name Game.**

- Draw a large circle on chart paper and give it the name *All Students*. See Fig SU.1(2).
  ✔ Ask for volunteers and select 4.
  ✔ Have the 4 students write their initials in the circle.
  ✔ Announce that this is the *All Students* circle and label it.

- Draw another circle outside the big circle. Put the initials of Student #1 in the circle.
  ✔ Announce this is *Student #1's* circle. Label it.
  ✔ Ask if the big circle still has the correct name now that Student #1 is not in it.
  ✔ Work to the idea that they need a new circle that does *not* include Student #1.

- Draw a *Not Student #1* circle at the side of the *Student #1* circle. See Fig SU.1(2). Have the remaining students put their initials in the new circle. Ask what a name for the circle might be.
  ✔ Work to the response the *Not Student #1* circle. Label it.

- Draw another circle below the *Not Student #1* circle. Put the initials of Student #2 in the circle.
  ✔ Announce this is *Student #2's* circle. Label it.
  ✔ Ask if the *Not Student #1* circle still has the right initials now that Student #2 is not in it.
  ✔ Work to the idea they need a new circle that does *not* include Student #2.

- Draw a *Not Student #2* circle at the side of the *Student #2* circle. See Figure SU.1(2). Have the remaining workers put their initials in the new circle. Then ask the students to name the circle and label it.
  ✔ Work to the response the *Not Student #2* circle.

- Draw another circle below the *Not Student #2* circle. Put the initials of Student #3 in the circle.
  ✔ Announce this is *Student #3's* circle.
  ✔ Ask if the *Not Student #2* circle still has the right name now that Student #3 is not in it.
  ✔ Work to the idea they need a new circle that does *not* include *Student #3.*

- Draw a *Not Student #3* circle at the side of the *Student #3* circle. See Figure SU.1(2). Have the remaining student put initials in the new circle.
  ✔ Ask if is it fair to call this circle *Not Student #3* since all other students have their own circle.
  ✔ Work to the response that since only *Student #4* is in the circle it could also be called *Student #4's* circle.

- Help the students add connecting lines to the chart to show how the classification of students was accomplished. Introduce the term *classification tree* for this type of chart.

- Ask the students to tell what they think a classification tree can tell them.
  ✔ Work to the idea that it shows how you think as you make selections of things or people.

4. **Use the items from one of the major categories in the Master Collection and introduce the Classification Game. See Figure SU.1(3) for an example with pencils. Place all**

items on a piece of chart paper on a table or the floor and go through their classification with the students.

Ask such questions as these:

- What is the name of the category?
  ✔ Write the name of the category in a box or circle containing all items.

- Can you divide these things into two categories so that things in one category will have a property and all the things in the other category will not have that property?
  ✔ Draw boxes or circle around the subcategories and help the students identify them with labels.
  ✔ The same name or logo is used for pairs of categories. Run a diagonal line through the *not* logo.
  ✔ Continue the subdivision and labeling as far as possible.
  ✔ Post the drawing showing the steps in subdivision.

- What did you use to separate one category of things from another?
  ✔ Work to the idea of using different properties of items.

- What kinds of properties did you use?
  ✔ Get at such things as differences in shape, color, materials, weight, size, and others.
  ✔ Give these things the names *physical properties* and *form.*

- How is this classification similar to the Name Game?
  ✔ Get at the idea that they are the same only one used people and the other objects.

5. **Organize the class into teams of 4–5 students. Give each team one of the major categories of things from the master collection. Have them classify the items, recording the steps and categories on a classification tree using Student Page SU.1 CLASSIFICATION TREE.**

Have the students

- Divide their major categories into two subcategories so that things in one subcategory have a property and things in the other category do not have the property.

- Draw boxes, connecting lines to show steps, and create identifying names or logos.

- Continue the subdivision as far as possible.

- Exchange classification sets and repeat the process.

6. **Use the master collection of items and introduce the Function Game to the class. Put four items from four different major categories on chart paper on a table or the floor. See Figure SU.1(5).**

   Ask such questions as these:

   - What do you use these things for?
     ✔ Get at such things as using them as classroom tools, using them to do work at school, or using them as tools in an office.

   - Does anyone know a word for the *uses of things*?
     ✔ Get students suggestions and home in on *function*.
     ✔ Draw a box or circle around the items and label the collective function category.

   - Can you divide these things into two categories so that things in one category have a special function and things in the other category do not have that function?
     ✔ Discuss possible divisions. If the students do not come up with an idea suggest one yourself. See Figure SU.1(4).
     ✔ Draw boxes or circles around the subcategories and help the students identify them with function names.
     ✔ Continue the subdivision as far as possible.

   - Can someone draw lines to show the steps used in the classification?
     ✔ Help the volunteer draw lines between the boxes or circles.
     ✔ Post the chart showing the steps in subdivision using function.

7. **Organize the class into teams of 4–5 students. Give each team four to six items from the different groups and a sheet of paper or Student page SU.1 on which to draw their classification steps or tree. Have them play the Function Game.**

   - Help them give their total collection a category name based on function.
     ✔ It can be the same as the one used in the introduction.

   - Help the students divide their categories into two subcategories so that things in one subcategory have a function and things in the other category do not have that function.

   - Help them draw boxes or circles, connect lines to show steps, and create identifying names as needed.

- Help the students continue the subdivision until each item has its own functional subcategory.
- Summarize the game.
  ✔ Ask if they have seen other trees like the one from the Function Game. Bring out the Name Game and physical properties classification trees.
  ✔ Ask how the trees are alike. Get at the idea that they are all used to sort and classify.
  ✔ Ask them what is meant by *category. Form. Function.*
- Summarize the importance of knowing about form and function.
  ✔ Ask the students how they use function in making their selection of items needed to go back to school. Work for selecting items to write with such as pens and pencils, things to write on such as paper and notebooks, and so forth.
  ✔ Ask the students how they use form in making their selection of items needed to go back to school. Work for selecting colors of pens, shapes of erasers, sizes of paper, and so forth.

DASH

CLASSIFICATION
TREE
SP SU.1

Name ______________________

Date ______________________

SU.2 WORKING DEFINITIONS

OBJECTIVES

The students
- Review the components of a working definition—form, function, and category.
- Practice making working definitions.
- Start to compile a working dictionary.

BACKGROUND

In this start up activity students new to DASH review the concepts of form, function and category introduced in Activity SU.1 CLASSIFICATION. They then use these ideas to identify the components in working definitions and to write some of their own.

Working definitions

Scientific progress relies on *working definitions* or operational definitions which describe the current understanding of a concept or term. These definitions are called *working* because they allow the work of science to go on, understanding that the definition may be changed or modified in the future.

Students' definitions

Research on children's development of definition indicates that the ideas they have about the world are constantly changed or modified by experience. DASH has called on these findings for guidance and therefore uses working definitions to support the students' continual shaping and reshaping of concepts and ideas.

A record of working definitions gives the students a way to keep track of their evolving thinking and learning. Working definitions provide teachers a window into the student's or the class's grasp of ideas. There should be a review of previous definitions whenever an already-defined concept re-emerges. When reviewed, a definition can be added to or changed.

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Focus Book
If available from a DASH kindergarten teacher, the Focus Book, *THE FRIENDLY SHAPE*, can be used with younger students to help them get a sense of working definitions. See Activity K.1.10 WORKING DICTIONARY AND WORKING DEFINITIONS in the *DASH Kindergarten Teacher Guide* for suggestions on using this book.

Evolving definitions
Beginning working definition may include only a category name and the thing's functions. For example: *A living thing grows, reproduces, and is a user of water.* Just as common a beginning working definition may include only a category name and the thing's forms. For example: *A living thing is made of wood or meat.* A more advanced working definition would join these pieces. *A living thing* (category name) *is made of wood or meat* (forms) and *grows, reproduces, and needs water* (functions). Beyond this simple model, a maturing working definitions may also include examples, synonyms, pictures or diagrams, and other information. Pictures and drawings in particular greatly enhance deeper understanding of a working definition.

The Working Dictionary
The Working Dictionary is most often a book with blank pages, frequently loose leafed or big book format, used to keep a record of definitions. It is suggested that a single page be devoted to each concept or term defined so that ideas can be added or changed. Entries should be dated. Initials of major student contributors can be added to help the teacher in assessment of student understanding. Working definitions *can include incorrect information* since definitions will undergo regular re-evaluation at which time corrections can be made. This is how science operates—it is always changing, growing, refining.

STUDENT ROLE

Lexicographer

MATERIALS

Focus Book *THE FRIENDLY SHAPE* (Optional)
master collection from Activity SU.1 CLASSIFICATION
chart paper
markers
Student Page SU.2 WORKING DEFINITION

PRODUCTS

Working definitions
Completed Student Pages

PROCEDURES

1. **Review the ideas developed in Activity SU.1 CLASSIFICATION with the students.**

   Ask such questions as these:
   - What does *category* mean? Can you give some examples.
     ✔ Work for the name for the group to which something belongs.
     ✔ Use the master collection from SU.1 to help students come up with concrete examples.

   - What is meant by *form*? Can you give some examples?
     ✔ Work for the physical characteristics of the thing, the materials from which it is made, and the parts of which it is made up.

   - What is meant by *function*? Can you give some examples?
     ✔ Work for the use of the thing or what it does.

2. **Introduce the students to the idea of a working definition by reading some and having them identify the three parts. Working definitions include a category or name; a function or what the thing does or how it is used; and its form or physical properties, materials it is made of, and its parts or components.**

Use such definitions as these:

- A refrigerator is an appliance used for keeping things cold and making ice. It is usually box-shaped, comes in many colors, has a door with a handle and shelves, and needs electricity to operate.

- Markers are writing tools that come in many colors. They have different sized tips and usually look like pens. They can be washable or permanent and often have special smells. They can be used for writing or drawing on all sorts of things such as paper, clothing, and people.

- Spoons are kitchen utensils used for eating, serving, measuring and stirring. They can usually be held in one hand. They are made from metals, ceramic materials and plastic. They usually have a handle to hold on to with a bowl-shaped part at one end.

3. **Help the students write a working definitions for one of the items in the master collection from Activity SU.1 CLASSIFICATION. Record their definition on chart paper. Have them identify the category, form, and function by circling each in a different color.**

4. **Have the students work in small groups to write working definitions for other items in the master collection from Activity SU.1 CLASSIFICATION. Use Student Page SU.2 WORKING DEFINITION. Have the groups exchange papers and identify the category, form, and function in the other group's definition by circling each in a different color.**

5. **Introduce the Working Dictionary to the students when writing class working definitions. See Activity SU.3 LIVING AND NOT LIVING.**

6. **At the end of the school year store the Working Dictionary in the library for the students to build on the next year.**

DASH

WORKING DEFINITIONS SP SU.2

Name ______________________

Date ______________________

SU.3 LIVING AND NOT LIVING THINGS

OBJECTIVES

The students
- Collect living and not living things.
- Describe and identify living, not living, never-living, once-living, and combination things and plants and animals.
- Write working definitions for living, not living, never-living, once-living, and combination things and plants and animals.

BACKGROUND

This start up activity follows Activities SU.1 CLASSIFICATION and SU.2 WORKING DEFINITIONS. This activity provides practice in classifying and writing working definitions as well as introducing several fundamental science concepts—living, not living, plants, animals, once-living and never-living. LIVING AND NOT LIVING THINGS also provides an opportunity to introduce the Wonder and Discover Book to students new to DASH.

The students first collect living and not living things. They classify their items to include the categories—living, not living, plants, animals, once-living, never-living, and combination things. Then they write class working definitions for these terms.

Student classification and working definitions
The concepts being introduced here are some of the most complex and difficult ones in science. The correctness and completeness of the classification and definition procedures suggested here will depend upon the prior experience and developmental level of the students. It is important to keep in mind that scientists themselves are not in complete agreement about these ideas. When questions arise they should be recorded in the Wonder and Discover Book.

STUDENT ROLES

Scientist
Classifier
Lexicographer

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MATERIALS

chart paper or a large sheet of oaktag
markers
clear plastic cups
recycled nylon stockings
baggies
3 X 5 cards
Working Dictionary
Wonder and Discover Book
Student Page SU.3 THE COLLECTION GAME

PRODUCTS

Classification chart about living and not living things
Working Definitions
Completed Student Pages

PROCEDURES

1. **Introduce the collection game. Have the students work in teams of two.**

   - Ahead of time divide a piece of chart paper in half. Label the two columns *Living* and *Not living*. Put the paper on a table. Figure SU.3 shows a suggested model for a finished chart. ✔ You may want to add a few items to the collection if the students do not collect them—something metal, a small rock, something plastic, a dead leaf, a dry seed, a piece of paper, a wood pencil with a metal eraser band, and a wood clothespin with a metal spring will help encourage the discussion.
   - Give each team a clear plastic cup or other container.
   - Have the students cover the cups with a piece of nylon stocking to let any animals they might collect breathe.
   - Instruct teams that they are to go outside and collect one living and one not living object to put in their container.
   - Have the students place their collected items in either the living or not living category on the chart paper.

978

2. Discuss and expand the classification with the students.

- Have them look at the items in each category and ask if they all agree with how things have been classified. Have the collector defend his choice of category.

- When there is agreement, have the students look at the living category and ask how it could be divided into just two groups.
  ✔ Work for *Plants* and *Animals*. There will hopefully be some disagreement from the purists who will suggest *Plants* and *Not plants* or *Animals* and *Not animals*. If needed remind the students of their two category or dichotomous classification activities. Both are correct although *Plants* and *Animals* are more commonly used.

- Divide the *Living* category column in two parts and label. Have the students place their living things into the two new categories.
  ✔ When they all agree, ask a few questions yourself about the dead leaf in the living category, the seed, and so forth.
  ✔ When there are unresolved questions, record them in the Wonder and Discover Book and create a new category for questionable items.

- Have the students look at the *Not living* collection. Ask if there is a way to divide the items into just two categories. Ask a specific question about the dead leaf and the piece of metal if needed.
  ✔ Work for the ideas of *Never-living* and *Once-living* things.
  ✔ There may again be some discussion from the purists who prefer *Once-living* and *Not once-living*. This is also correct although the former is more commonly used.

- Divide the *Not living* category column in two parts and label. Have the students place their not living things into the two new categories.
  ✔ When they all agree, ask a few questions yourself about the plastic in the never living category, the seed, and so forth.

- Pick up the pencil, clothespin or other combination item and ask where it belongs. Help the students to invent a Combination category and add it to the chart.

- Have the students attach items to the chart.
  ✔ Draw pictures of any live animals and return them to where they were collected.
  ✔ Bulky items can be placed in baggies and attached to the chart.

4. **Have the students write working definitions for living, not living, once-living, never-living, and combination things and plants and animals. Remind them to include category, form, function, and examples.**

   - Divide the class into seven groups and assign them a color to write with.
   - Give each group a sheet of paper from the Working Dictionary with a different category to define from the above list.
   - Have them write a working definition in their assigned color for their term.
   - After ten or so minutes have them pass their papers to another group in a round-robin fashion. The new group may make additions and corrections to the definition using their assigned color.
   - Continue this passing process every 2 to 3 minutes until all groups have worked on all the definitions or time runs out.
   - Have the original groups share the completed definitions, ask for any further input, and put the pages in the Working Dictionary.

5. **These definitions should be returned to periodically for revision.**

ILLUSTRATION

<table>
<tr><th colspan="4">All Things
(Matter)</th></tr>
<tr><th colspan="2">Living Things</th><th colspan="2">Not Living Things</th></tr>
<tr><th>Animals</th><th>Plants
(Not Animals)</th><th>Once Living Things
(Not Never Living)</th><th>Never Living Things</th></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td></td><td></td></tr>
<tr><td colspan="2">Combination Things</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="4">Wonder and Discover Things</td></tr>
<tr><td colspan="4"></td></tr>
</table>

Figure SU.3 A suggested model for a completed chart about classifying living and not living things.

DASH

LIVING AND NOT LIVING
SP SU.3

Name ____________________

Date ____________________

<table>
<tr><td colspan="4">All Things
(Matter)</td></tr>
<tr><td colspan="2">Living Things</td><td colspan="2">Not Living Things</td></tr>
<tr><td>Animals</td><td>Plants
(Not Animals)</td><td>Once Living Things
(Not Never Living)</td><td>Never Living Things</td></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td></td><td></td></tr>
<tr><td colspan="2">Combination Things</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="4">Wonder and Discover Things</td></tr>
<tr><td colspan="4"></td></tr>
</table>

DASH 3.1.4 PLANNING

OBJECTIVES

The students
- Keep a planning calendar.
- Use the planning calendar to initiate plans for special activities.

BACKGROUND

This activity is an ongoing part of the DASH time theme. It is designed to aid students in anticipating and planning for holidays, vacations, birthdays, major school events, and classroom projects. The Planning Calendar is used to remind the class of upcoming events. It identifies the day events occur. These events are recorded on the Learning Calendar as they occur.

The Planning Calendar is a standard commercial calendar on which all important upcoming events are written. This calendar shows the whole year on one large sheet. It specifies a weekly planning time when future events are discussed. This is also the time when the Responsibility Chart from Activity 3.1.3 RESPONSIBILITY is updated. Planning is probably best done on the first or last day of the week.

If a year calendar on a single sheet of heavy paper cannot be easily obtained from a stationery store, one can be made on a large sheet of oaktag.

STUDENT ROLE

Planner

MATERIALS

calendar for a year on one large sheet of heavy paper
markers
Student Page 3.1.4 MONTHLY PLANNING CALENDAR

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PRODUCTS

The Planning Calendar
Completed Student Pages

PROCEDURES

1. **Introduce the Planning Calendar to the students by discussing the need to know about and plan for future events. Have them decide how to record information.**

2. **Have the students plan for the coming month using Student Page 3.1.4 MONTHLY PLANNING CALENDAR.**

   - As things are recorded on the Planning Calendar, have the students record them on their Monthly Planning Calendars.

   - Once the students are familiar with the planning and recording procedures, information can just be recorded on the Planning Calendar.

3. **Have the class plan for upcoming events and projects. Have them update their Planning Calendar and Student Page 3.1.4 MONTHLY PLANNING CALENDAR once each week at planning time or as appropriate.**

   Ask questions such as these:
   - What holidays are coming?
   - What birthdays are coming?
   - What special school events are coming?
   - Are there special school events we should plan for?
   - Are there vacations we should plan for?
   - Are there other things we should be planning for?

4. **Have the students form a planning committee to remind the class when some action is to be taken.**

EXTENSIONS

- Have the students invent logos to represent various upcoming events.
- Have the students ask their parents how they make plans.
- Have the students ask their parents how planning is done where they work.

DASH

MONTHLY PLANNING CALENDAR
SP 3.1.4

Name: ____________________

Date: ____________________

Month:

Sun	Mon	Tues	Wed	Thurs	Fri	Sat

3.1.5 ORGANIZING OUR ENVIRONMENT

OBJECTIVES

The students
- Create a concept map of the term, "organize."
- Identify things that need to be organized in the classroom.
- Develop and carry out a plan of organization.

BACKGROUND

The theme of organization begins in kindergarten and continues through grade six. It is designed to fill a need for safety and ease of operations in the school environment. One of the great innovations of modern technology has been the organization of the workplace and the things within it. Education is a combination of art and technology. The smooth operation of the classroom is greatly facilitated by organization.

In this activity the students identify the kinds of things that can be organized to help the flow of ideas, people, and materials in the classroom. These should include such things as the organization of their notebooks, the contents of their desk, the storage of materials, and the reinforcement of regular and orderly performance of responsibilities.

STUDENT ROLES

Industrial designer
Planner

MATERIALS

chart paper
markers
Student Page 3.1.5 ORGANIZING

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PRODUCTS

Concept map on term organize
Completed Student Pages

PROCEDURES

1. **Have the students create a concept map of the term organize.**

   Help them include examples of
   - Planning.
   - Putting things in order.
   - Putting things away.
   - Storing things.
   - Deciding on the procedures for doing things.
   - Making things easier.
   - Making work safer.

2. **Have the class discuss things that have already been organized this year and things that still need to be organized.**

   Help the students include such things as
   - Jobs on the Responsibility Chart.
   - Information on the Learning Calendar.
   - Work in their notebooks.
   - Things in their desks.
   - Materials stored in the classroom.
   - Distribution of materials to the class.

   Have the students refer to their concept map on the term organize to explain why such organization is useful.

3. **Have groups of students plan an organizational structure or procedure for each of the items identified as needing organization in Procedure 2.**

   Have the students
   - Use Student Page 3.1.5 ORGANIZING to record their plans.
   - Report to the class on their organizational plans.
   - Agree upon a class plan for each item.

4. **Periodically have the students check to see that their organizational plans are being carried out.**

EXTENSIONS

- Have the students ask their parents and others how their workplaces are organized.
- Have the students report on how they organize their own things at home.

DASH

ORGANIZING
SP 3.1.5

Name: ______________________

Date: ______________________

A Plan for Organizing ______________________________

Planning Group: ____________________ ____________________

____________________ ____________________

1.2.8 NIGHT AND DAY

OBJECTIVES

The students
- Collect data about sunlight and seasonal change.
- Observe that the length of one day-and-night cycle is about 24 hours.
- Correlate changing length of day with seasonal changes.
- Correlate day and night length with solstices and equinoxes.
- Practice using digital time.

BACKGROUND

This year-long activity should be started about 2 weeks after sunrise and sunset data collection becomes routine. Students convert the data from Activity 1.2.7 SUNRISE AND SUNSET into linear representations of time with string or tape. The string or tape can be colored with marking pens, crayons, or even chalk.

During the year a series of correlations are made as students work toward an understanding of seasons.

STUDENT ROLE

Astronomer

MATERIALS

class chart day and night
tape or string
yellow and black crayons, markers, or chalk
stapler
time line from Activity 1.2.6 TIME LINE
scissors
glue
Student Pages 1.2.8A CLASS TIME LINE
1.2.8B DAY AND NIGHT IN SUMMER

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PRODUCTS

Class chart day and night
Class time line
Completed Student Pages

PROCEDURES

1. **Establish the need for the class chart day and night.**

   Have the students construct a month-by-month time line for the chart using Student Page 1.2.8 CLASS TIME LINE.

   Ask such questions as these:
   - What seems to have happened to the length of the day since we have started keeping records?

   - How can we tell?

2. **Demonstrate using the digital time line from Activity 1.2.6 TIME LINE to represent the daylight hours between sunrise and sunset. See Figure 1.2.8.**

   - Cut a piece of tape or string as long as the 24-hour time line.

   - Place the tape along side the time line.

   - Mark the times of sunrise and sunset on the tape.

   - Color the tape yellow between sunrise and sunset.
     ✔ Day.

   - Color the remainder of the tape black.
     ✔ Night.

   - Attach the tape to the chart under the appropriate date on the class time line.

   Have each group make one or more representations of daylight length for previously collected sunrise and sunset data.

   A new tape should be added to the class chart at least once each week.

3. **Discuss correlation 1, days get shorter and nights get longer in fall.**

   Explore the length of night and day after a month.

   Ask such questions as these:
   - How long is the night?
   - How long is the day?
   - What is happening to the length of the day and night?

4. **Discuss correlation 2, the length of day plus the length of night are equal to about 24 hours.**

   Ask such questions as these:
   - How long a time is it from sunrise to sunrise?
   - How can we find out?
     ✔ There are several ways: (a) Measure directly on the time line. Put 2 time lines together using one as a time ruler. (b) Put night and day tapes end to end and measure on the time line. (c) Calculate.

5. **Discuss correlation 3, the lengths of day and night are the same on September 23, the first day of fall.**
   - Around the middle of September have students find out the date of the first day of fall.
   - Have students predict what might happen to the length of day and night on that date.
   - After the date have students make correlations between the equinox and the first day of fall.

6. **Have students record their predictions about what will happen next to the length of day and night on the Learning Calendar.**
   - Watch to see whether their predictions are correct.
   - Have students continue to make predictions after each discussion.

7. **Discuss correlation 4, December 22, the first day of winter, has the longest night and the shortest day.**

   - Two weeks before Christmas vacation, ask students to find out when the first day of winter will be.
     ✔ Suggest that they may use the radio, TV, newspaper, their parents, etc., as information sources.

   - Continue sunrise and sunset data collection over the vacation.

   - On return from vacation, correlate day and night length with the first day of winter.

8. **Discuss correlation 5, days get longer and nights shorter as the winter progresses.**

   Begin any time after the students return from Christmas vacation.

   Ask such questions as these:
   - What seems to be happening to the length of the day?

   - When did this seem to start?

   - How long do you think this will go on?

9. **Discuss correlation 6, the lengths of day and night are the same on March 21, the first day of spring.**

   - Around the beginning of March ask students to find out when the first day of spring will be.

   - Ask students to predict what will happen to the length of day and night on that day.

   - After the event make correlations between the equinox and the first day of spring.

10. **Discuss correlation 7, days continue to get longer and the nights shorter in the Spring.**

    A week or so after the Spring Equinox ask such questions as these:
    - What is happening to the length of the day?

    - How long do you think this will go on?

- Can you predict when there might be a change?

11. **Right before summer vacation, challenge students to find out if and when the days start to get shorter again over the summer.**

    Use Student Page 1.2.8B DAY AND NIGHT IN SUMMER to record data.

EXTENSIONS

- Have students make a day-and-night graph for shorter time intervals. Have them graph data every day or every other day.
- Have students record the total time from sunrise to sunrise on the Learning Calendar. Students may notice the times are a bit longer than 24 hours for some seasons and shorter for others.

ILLUSTRATION

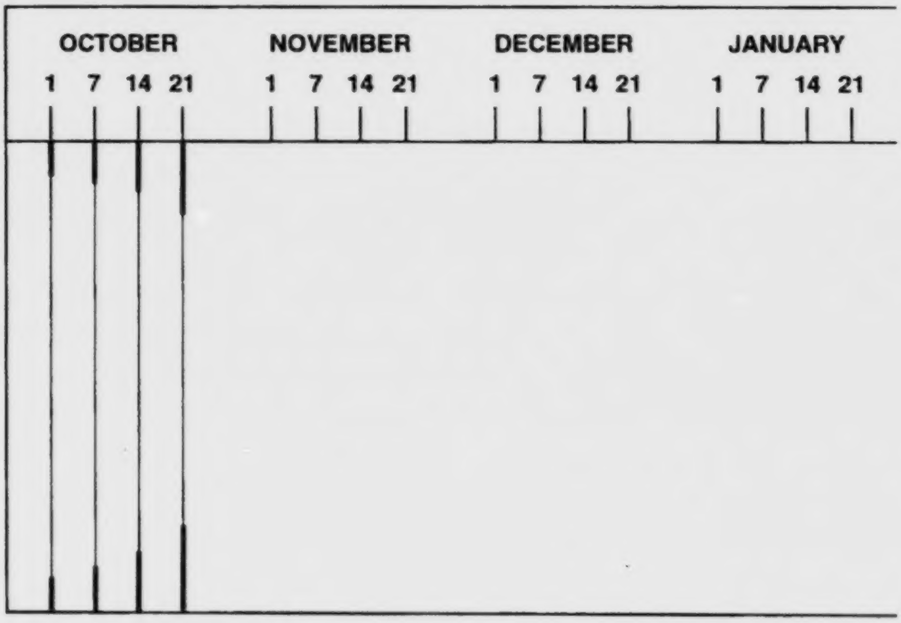


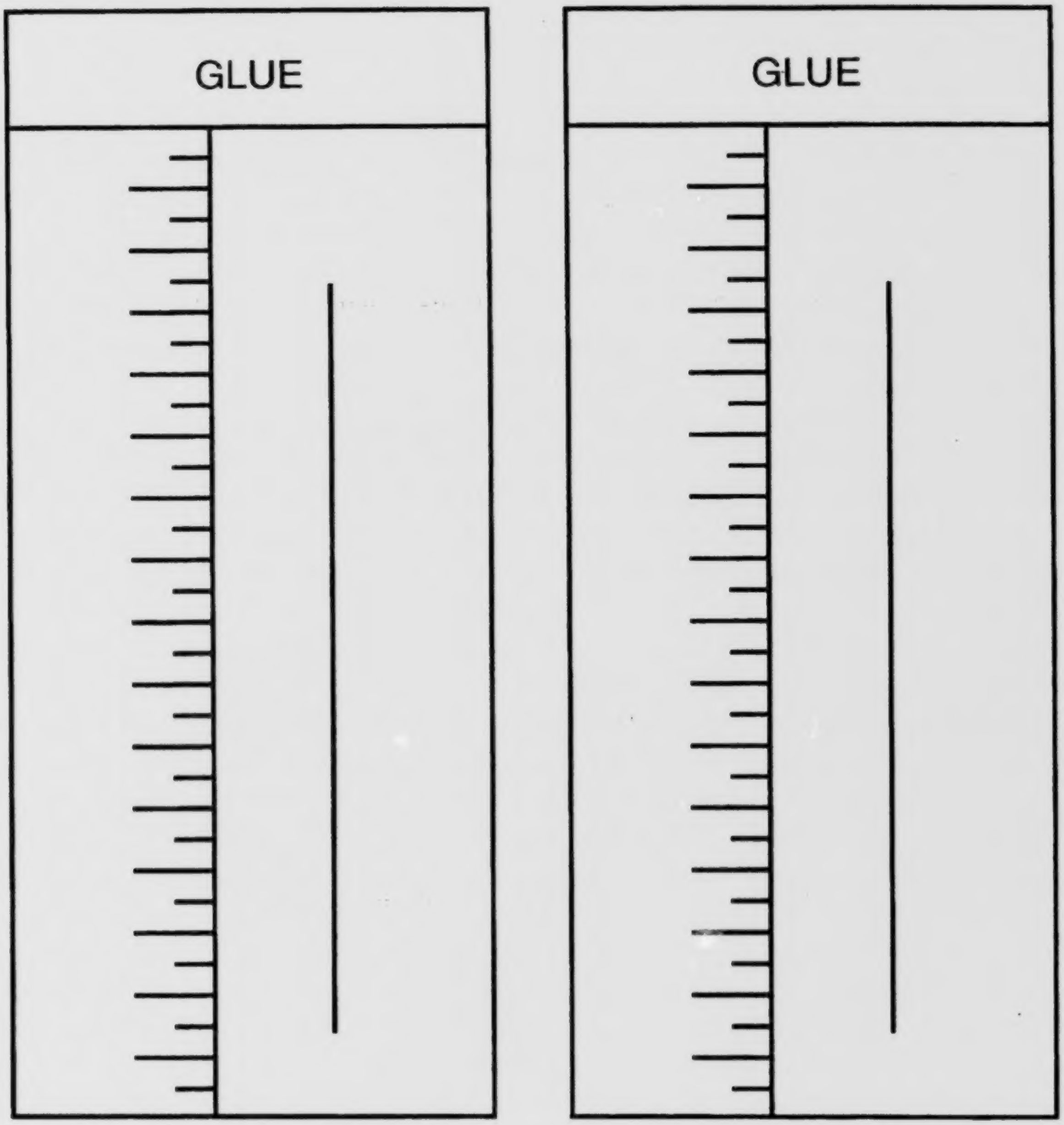
FIGURE 1.2.8 Night and Day

DASH

CLASS TIME LINE 1.2.8A

Name: ____________________

Date: ____________________



Cut one strip for each month. Each one-half centimeter is equal to one day. Cut off excess for months with fewer days. Label months. Glue strips together. Begin with current month.

DASH

DAY AND NIGHT IN SUMMER
1.2.8B

Name: ______________________

Date: ______________________

DATE	SUNRISE	SUNSET	OBSERVATIONS

2.2.7 DIGITAL TIME

OBJECTIVES

The students
- Review how to read a digital clock.
- Make a 24 hour digital time line.
- Learn how to use a digital time line to find the time between events.
- Calculate the time between events.

BACKGROUND

Digital time is introduced in DASH 1. Now students learn to calculate lapsed time or the time between start and finish using multiple time lines. In the DASH 2 we also introduce analog time for the calculation of time lapse.

Review

DIGITAL TIME is designed to be used with Activities 2.2.3 SUNRISE, SUNSET, AND SEASONS, 2.2.4 MOONRISE AND MOONSET, and 2.2.8 ANALOG TIME. Digital and analog clocks are tools. In keeping with the general philosophy of DASH, the use of tools is taught in the context of an activity in which the tools are used. Such an approach provides the students with an immediate reason for mastery of the tool and an environment in which to explore and practice its use.

The 24 Hour Time Line

Two common methods of reporting time are in two 12 hour intervals before and after noon (A.M. and P.M.) and in one 24 hour interval. The later is used extensively by the military. Both methods are used here. Conceptually the 24 hour interval is actually easier for students to grasp and can be used before introducing the A.M. and P.M. method.

No DASH 1 Background

Some students probably will not have had DASH 1, so this activity may be their first exposure to digital time. It will accelerate mastery if these students are paired with students who have previously worked with digital time.

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Time Intervals

Time intervals can be determined by using two time lines. Use one time line to mark the beginning and end of the interval to be measured. Use the second timeline as a ruler. Place the 0 hour of the ruler at the beginning of the interval and then measure the number of hours and minutes to the end of the interval.

STUDENT ROLES

Astronomer
Mathematician

MATERIALS

digital class clock
digital watches
scissors
glue
pencils
markers
Student Page 2.2.7 DIGITAL TIME LINE

PRODUCTS

Time lines

PROCEDURES

1. **Introduce the activity by showing a digital clock.**

   Ask such questions as these:
   - Can anyone tell us what time it is now? Reset the clock and repeat the question several times.
   - Can anyone tell us how to read a digital clock?
   - Go to the P.M. readings. Can anyone tell us what P.M. stands for?
     ✔ Work for two ideas—the literal translation, *post meridian*, meaning after the sun passes overhead at noon, and that it tells us when it is afternoon and evening.

- Go to the A.M. readings. Can anyone tell us what A.M. stands for?
  ✔ Work for two ideas—the literal translation, *antemeridian*, meaning before the sun passes overhead at noon, and that it tells us when it is morning.

- Can anyone tell us when the clock changes from A.M. to P.M.? What time is that?
  ✔ Work for noon.

- Can anyone tell us when the clock changes from P.M. TO A.M.? What time is that?
  ✔ Work for midnight.

2. **Introduce Student Page 2.2.7 DIGITAL TIME LINE. Each time line will require 8 copies, there being 3 strips on a copy. One strip equals one hour.**

   Help the students
   - Assemble their time lines.

   - Label A.M. and P.M. on the time line.
     ✔ A different colored stripe along one edge of the timeline can be used for A.M. and P.M.

   - Number as a 24-hour digital time line.

3. **Use the digital time line with Activity 2.2.3 SUNRISE, SUNSET, AND SEASONS and 2.2.4 MOONRISE AND MOONSET to measure the time between rising and setting events. Two or more time lines will be needed.**

   Have the students
   - Mark the time of rising and setting on one time line.

   - Use another timeline to measure the interval between rising and setting.

EXTENSIONS

- Suggest to parents that an analog watch makes an ideal present for students.

- For students who have both an analog and a digital watch, suggest that they wear both. Form a "Two-Watch" club.

- Label one class timeline with both 24 hour time and A.M. and P.M. times for easy conversions from one system to the other.

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DASH

DIGITAL TIME LINE
SP 2.2.7

Name: ____________________

Date: ____________________

GLUE	GLUE	GLUE

2.2.8 ANALOG TIME

OBJECTIVES

The students
- Relate digital time readings to analog time readings.
- Construct a model of an analog clock.
- Explore the use of the analog clock.
- Practice using the analog clock.

BACKGROUND

The digital clock was introduced in DASH 1 and is use in DASH 2. In DASH 2 the analog clock is introduced for the first time. DASH employs this sequence because the digital clock is usually much easier for students to learn and many have prior experience with it. Knowing how to read digital time makes analog time much easier to master. However, there are disadvantages to digital clocks. They are unidirectional; one can read only time after the hour directly from a digital clock and one has to perform mental arithmetic to calculate time before the hour. Further digital clocks are not always available and students need to know both systems.

In keeping with the general philosophy of DASH concerning the teaching of tools, time is taught in a context in which it is used. The analog clock can readily be introduced whenever an activity involves time. Practice is natural whenever the time of day needs telling.

ANALOG TIME should follow 2.2.7 DIGITAL TIME. It should not be introduced until newcomers to DASH have gained some proficiency in reading digital time. To ensure that the analog clock is used, it is suggested that any digital clocks be removed from the room while the reading of analog clocks is being mastered.

STUDENT ROLE

Timekeeper

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MATERIALS

time lines from Activity 2.2.7 DIGITAL TIME
analog clock
paper plates for clock faces (preferably without indentations in rim)
paper fasteners
index cards to make hands
scissors
pencil
Student Page 2.2.8 ANALOG CLOCK

PRODUCTS

Analog clocks

PROCEDURES

1. **Set the stage by announcing that because we have to give up our digital clocks and rely upon analog clocks for the next month, the students will need to learn to read an analog clock.**

   Ask such questions as these:
   - Does anyone know what an analog clock is?

   - Does anyone know how to read an analog clock?
     ✔ Those who do can be your assistants.

2. **Turn a digital time line into an analog clock by shaping it into a circle and adding hands. Ask what has been made?**

3. **Have the students make a 12-hour analog clock face using Student Page 2.2.8 ANALOG CLOCK.**

   Have them
   - Cut out the face and glue it to a paper plate.

   - Attach the minute hand with a brass paper fastener.

4. **Have the students inspect their analog clocks.**

   Help them
   - Recall that there are 60 minutes in an hour.

- Discover that there are 12 large lines on the clock face for numbers.
  ✔ Have them write in the numbers 1–12 on their clock face.

- Discover that there are 12 groups of 5 minutes each represented on the face and that their total is 60 minutes.
  ✔ Practice counting by five's.

- Discover that they can count by 5 and single minutes to find the total number of minutes past the hour.
  ✔ Practice with different settings.

5. **Have the students remove the fastener and add the hour hands to their clocks and practice time settings.**

With them

- Go over hour settings for one o'clock and two o'clock, then help the students discover other hour settings.

- Introduce a setting for 5 minutes after one o'clock, then help the students discover the remainder of the series of minutes in-5 minute intervals.

- Help the students discover how to set the clock for other intervals by giving them practice challenges.
  ✔ Have students help each other.

- Introduce half and quarter hours.

- As soon as possible get the students to use their new knowledge in the role of Time Keepers.

6. **When the students are proficient, help them discover that analog clocks can also be read in terms of minutes *before* the hour. Have the students use their clocks.**

Ask such questions as these:

- If someone asks *How many minutes is it before twelve o'clock?* when the clock reads 45 minutes after eleven, how could you figure out the answer?
  ✔ Have students help each other to solve this and other such challenge times.

- When might we want to know how long it will be before twelve o'clock?
  ✔ Practice before-the-hour readings.

EXTENSIONS

- Have the students play Time-Set games.
  Game 1. Give the students a challenge time of so many minutes *after* the hour. Allow them 30 seconds to set their clocks. After a while give them 25 seconds to set them, then 20 seconds and so forth down to about 10 seconds.

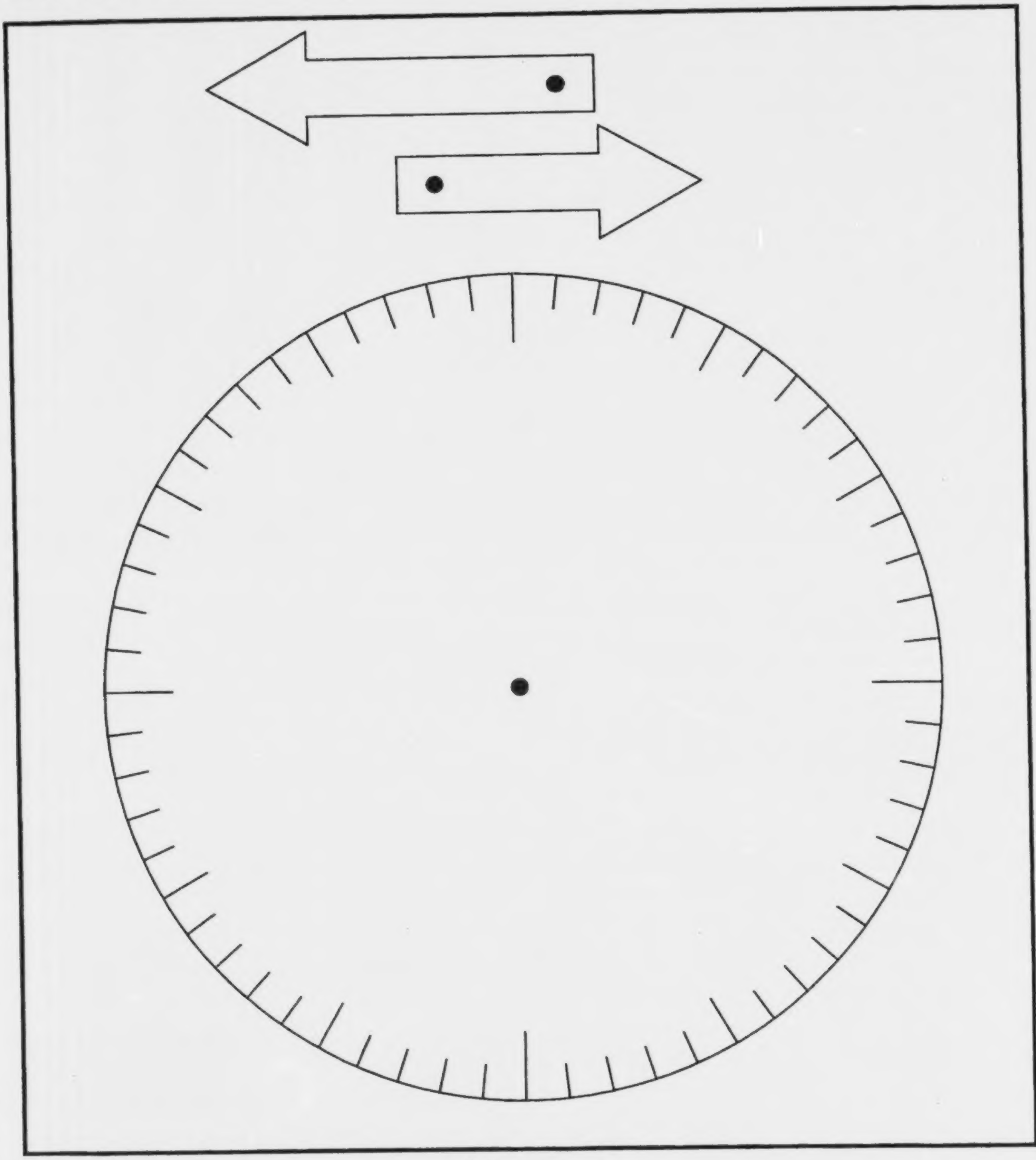
  Game 2. Give the students a challenge time of so many minutes *before* the hour. Allow them 30 seconds to set their clocks. After a while give them 25 seconds to set them, then 20 seconds and so forth down to about 10 seconds.

DASH

ANALOG CLOCK
SP 2.2.8

Name: ____________________

Date: ____________________



K.2.7 MOON PHASES

OBJECTIVES

The students
- identify, record, and report the moon phases
- use cards to show the natural sequence of moon phases
- identify the moon as one of nature's clocks

BACKGROUND

The sun is a natural clock because of its regular appearance. Because the moon appears at regular intervals, it too can be used as a natural clock.

In the previous activity, the students counted the days between two full moons. In this activity they count the days and watch the phases between two new moons. The students find out whether the period between the new moons is the same as the period of the full-moon cycle. They also use their observations to make a Moon Clock.

STUDENT ROLES

Astronomer
Record keeper
Timekeeper
Clockmaker

MATERIALS

Learning Calendar (see Activity K.1.1 THE LEARNING CALENDAR)
markers
crayons
glue
paper plates
brass fasteners
index cards
hole punch
chart paper

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letter to parents
Student Pages K.2.7 A NEW MOON
K.2.7 B–C SEQUENCE CARDS
K.2.7 D MOON CLOCK
K.2.7 E MOON PHASES

PRODUCTS

Class chart of moon phases
Moon Clocks
Completed Student Pages

PROCEDURES

1. **Review Activity K.2.6 MOON WATCH with the students.**

   Ask such questions as these:
   - How many days are in a moon cycle?
   - What did the moon look like during the moon cycle you watched?
   - When is the best time to watch the moon?
   - Do you think the moon can act as a natural clock?
   - What do you think a new moon looks like?

2. **Explain to the students that they will count the days from one new moon to the next and watch the moon phases.**

   Have the students do the following:
   - Describe and compare the various shapes (phases) the moon seems to have.
   - Use these shapes to make a class chart of moon phases. (Help them name the phases as necessary.)

3. **Ask the parents to help their children observe the moon every evening or whenever possible.**

   - Send a note to parents explaining the assignment. Include Student Pages K.2.7A NEW MOON and K.2.7E MOON PHASES.
   - Have the students predict the number of days from one new moon to the next. Help them record their predictions on Student Page K.2.7A NEW MOON.
   - Beginning with a new moon, have the students identify the moon phases and count the days until the next new moon. Have them use Student Page K.2.7A to record their observations.

- Explain to the parents that their child should report that the moon is not visible when weather conditions prevent observation.

4. **When the moon is visible during the day, take the class outside to see it.**

5. **Have the students report and record their data on the Learning Calendar.**

   Help them do the following:
   - Draw the moon phases on the Learning Calendar.
   - Mark the new moon, the beginning of a cycle.
   - Draw the moon phase for each day they see the moon.
   - Mark the next new moon, the ending of the cycle.
   - Count the days between new moons.
   - Record the count on their calendar.

6. **Discuss the moon watch with the class.**

   Ask such questions as these:
   - How many days are in a moon cycle starting with the new moon?
   - How many days are there from the new moon to the full moon?
   - How many days are there from the full moon to the new moon?
   - What are the moon phases in the order you saw them?
   - How are the moon phases alike? How are they different?
   - How are the full and new moon cycles alike?
   - How are they different?
   - What are some patterns in the moon cycle?

7. **Have the students cut out the set of large moon phases from Student Pages K.2.7B and K.2.7C SEQUENCE CARDS and put them in order.**

   Some students may arrange the cards in a linear sequence while others may form a circular sequence. Have them share and explain their sequences. Encourage the students to make any modifications they wish.

8. **Before the lesson, prepare materials for making clocks.**

   Cut index cards into enough strips so that each child has a pointer for the Moon Clock.

Help the students do the following:

- Cut one end of their strip to a point.
- Punch a hole in the opposite end and insert a brass fastener.
- Mark the centers of the paper plates.
- Make holes through the marks for inserting the brass fasteners and pointers.

9. **Help the students make a Moon Clock. Have them cut out the set of small moon phases from Student Page K.2.7D MOON CLOCK.**

   - Ask the students where they would place the new- and full-moon cutouts on their paper plate. (Note that the period between a new moon and a full moon is half a cycle, so they would place the new moon across from the full moon [180 degrees] on the plate.)
   - Have the students lay the rest of the moon phase cutouts in order on the clock face. (If the students divide the plate into four quarters, they will put the quarter moons at right angles to the full and new moons.)
   - Have the students make a clock by gluing their set of cutouts onto the plate.
   - Help the students attach a pointer to the center of the plate with a brass fastener.

10. **Have the students test to see whether their clocks are accurate.**

    Have them do the following things:

    - Direct the pointer to the current moon phase.
    - Move the pointer to show the next phase as the moon phase changes. (If their clocks are accurate, the pointer will move in the same order as the moon phases appear.)
    - Redo the clock to correspond to their observations if necessary.
    - Look at subsequent moon cycles as a way of validating their data.

EXTENSIONS

- Read Frank Asch's *Happy Birthday Moon!* to the class.
- Celebrate the moon's birthday. Point out that the new moon is the beginning of another cycle and another birthday. Students can join in the planning of the "party."
- Have the students make a linear Moon Clock from the moon-phase cutouts.

- Use the Moon Clock to keep track of the moon cycles in a year. Label the clock face from 1 to 12 as in an analog clock. Add another pointer to the clock for counting the cycles in a year. Move the pointer each time a moon cycle ends.
- Have the students make a large class Moon Clock.

DASH

NEW MOON
SP K.2.7A

Name ______________________

Date ______________________

Prediction	Observation
I think it will be _____ days until the next **new** moon	I counted _____ days from one **new** moon to the next.

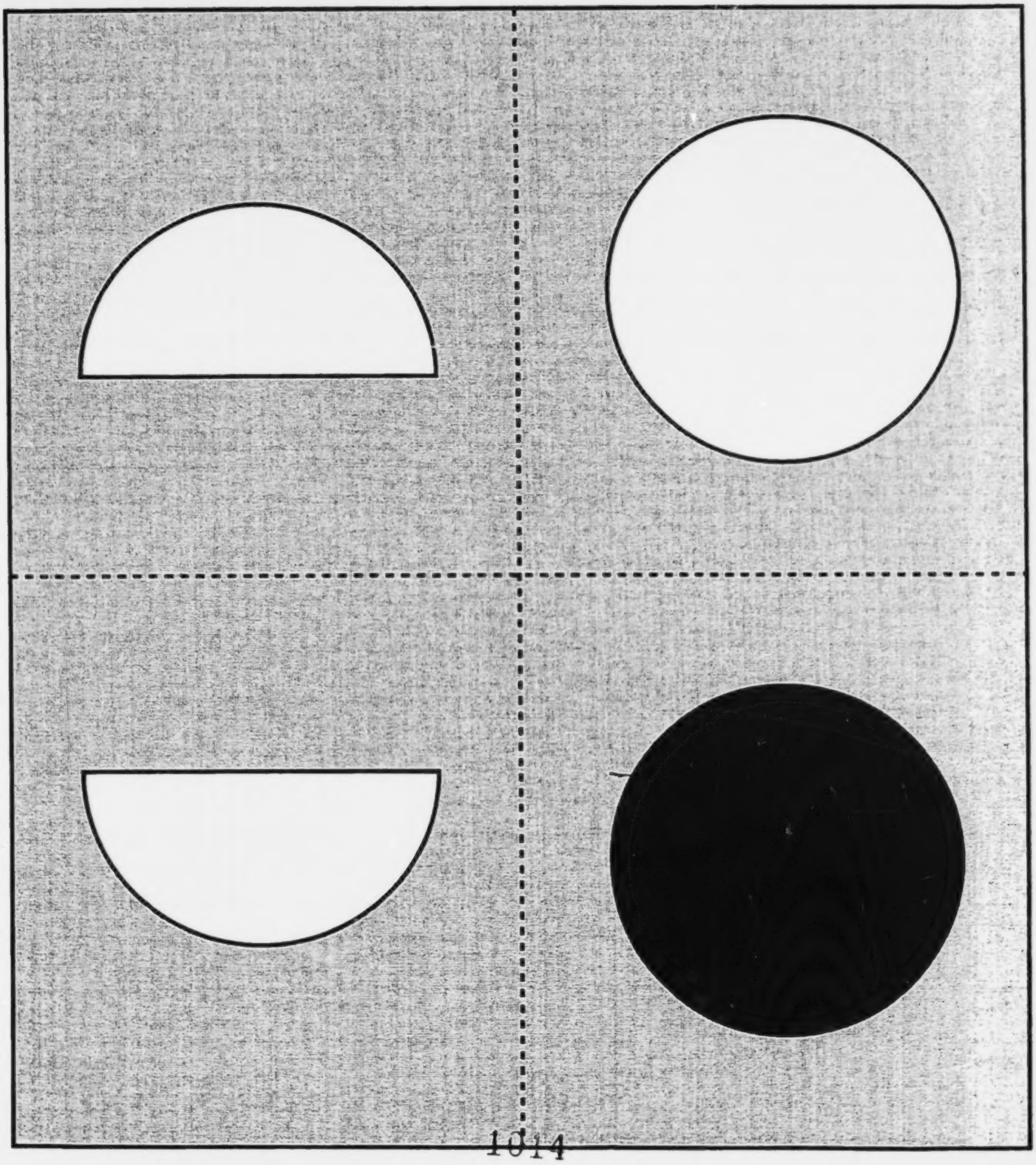
new ●	○	○	○	○	○	○
○	○	○	○	○	○	○
○	○	○	○	○	○	○
○	○	○	○	○	○	○
○	○	○	○	○	○	○

DASH

SEQUENCE CARDS
SP K.2.7B

Name ____________________

Date ____________________

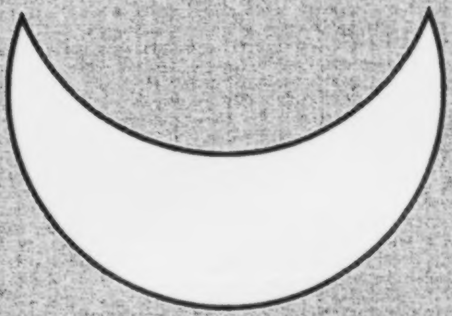


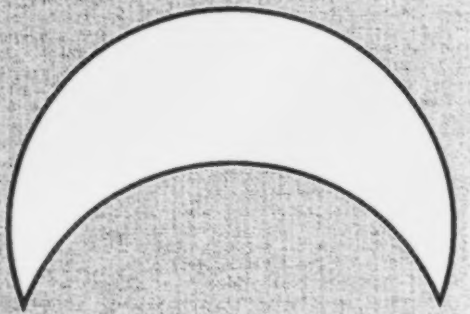
DASH

SEQUENCE
CARDS
SP K.2.7C

Name ______________________

Date ______________________



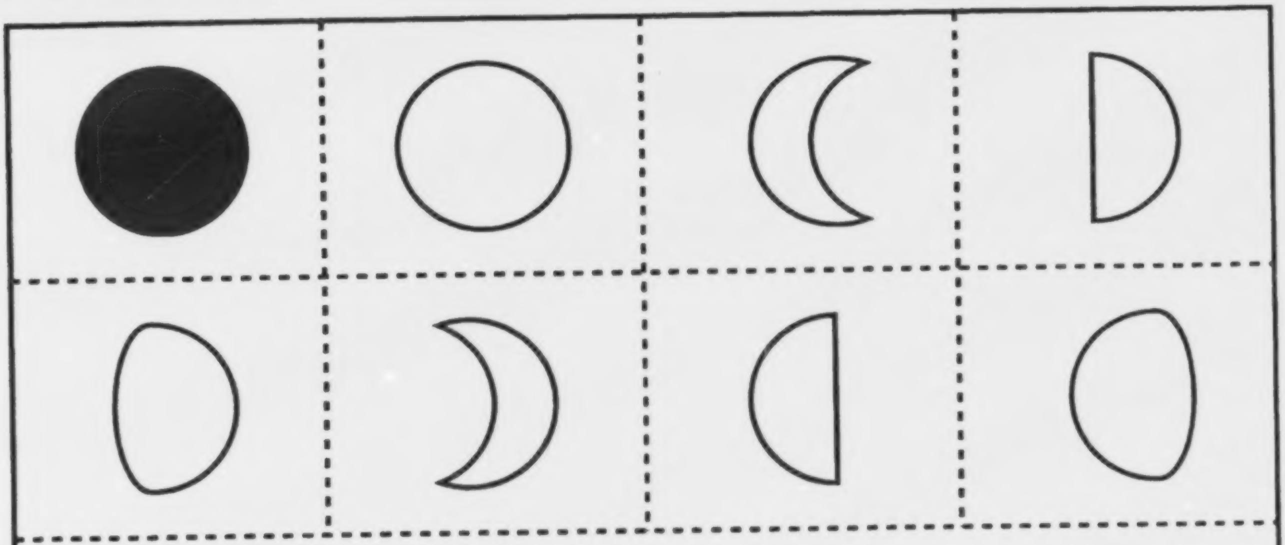


DASH

MOON CLOCK
SP K.2.7D

Name ______________________

Date ______________________

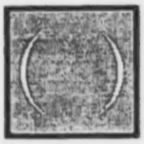


DASH

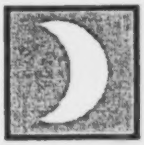
MOON PHASES
K.2.7E

Name ______________________

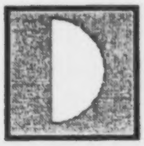
Date ______________________



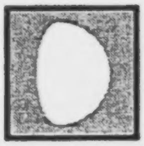
NEW: darkened or very dimly lit.



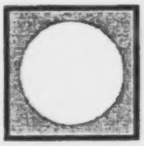
CRESCENT: smaller than half of the moon's face.



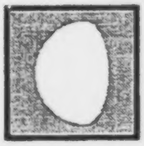
FIRST QUARTER: half of the moon's face is visible.



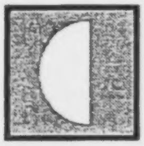
GIBBOUS: appears larger than a quarter moon yet is not full.



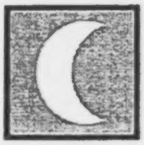
FULL: entire face of the moon is seen.



GIBBOUS: appears larger than a quarter moon yet is not full.



LAST QUARTER: half of the moon's face is visible.



CRESCENT: smaller than half of the moon's face.

3.2.7 MOON PHASES

OBJECTIVES

The students
- Graph moonrise and moonset.
- Determine the length of the moon cycle.
- Determine the length of each phase of the moon cycle.
- Verify their determinations.

BACKGROUND

In this activity the students determine the precise interval from one new moon to the next. The activity is introduced after several moon cycles have been recorded on the Learning Calendar and graphed as was done in grade two. Almanac and calendar data from previous years can alternatively be used to preserve the ongoing inquiry. Once the students make their predictions, they observe the phases of the moon. In previous grades students predicted the rise of the next new moon. In grade three they predict with greater precision.

This is an opportune time to learn the mnemonic:

> Thirty days has September,
> April, June, and November.
> All the rest have 31
> Save February's 28 days of fun.
> Leap year is filled out just fine
> When February gets 29.

The activity is introduced just prior to a new moon. The students are asked to predict when the next new moon will be. Counting the days from one new moon to the next will give 29 or 30 days. This provides an adequate way of predicting the beginning of the next moon cycle, but it also introduces an irregularity in a system that seems very regular. A solution to the problem is to average the time by counting the total number of days that it takes the moon to go through three to four cycles. This number is then divided by the number of cycles, giving an average of 29-1/2 days. The solution should be invented by the students. Verification comes by watching the moon through the

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next several cycles and by checking with resources such as a newspaper or almanac.

STUDENT ROLES

Astronomer
Mathematician

MATERIALS

Connections Book
Wonder and Discover Book
newspapers, almanac, or other source of moon data
Student Pages 3.2.7A MOON GRAPH
3.2.7B MOON PREDICTIONS

PRODUCT

Completed Student Pages

PROCEDURES

1. **Have the students make a class graph of moonrise and moonset for three or four cycles. Use SP 3.2.7A MOON GRAPH. Have them record moonrise and moonset times on the Learning Calendar.**

2. **Have the class predict the amount of time between new moons. Have them record their predictions on SP 3.2.7B MOON PREDICTIONS.**

   Ask such questions as these:
   - How did you make your predictions?
   - Do you think that the time between new moons is the same for each moon cycle?
   - How did the data collected so far this year help make predictions?
   - Can you invent a way to make more precise predictions about the next new moon using the data collected so far this year?

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3. **Have student groups invent a way to predict when the next new moon will occur. Have them use almanac data, Student Page 3.2.7B MOON PREDICTIONS, the class moon graph, and data from the Learning Calendar.**

Ask such questions as these:

- What is your prediction of the amount of time between new moons?
  ✔ If a 29, 30, 29, 30, 29, 30 sequence of days and then a 29-1/2 day period evolve, have the students discuss their ideas. If only one of these solutions is suggested, continue with the following questions.

- How can a pattern such as 29, 30, 29, 30 occur when the moon cycle seems so regular?
  ✔ Work toward the idea that maybe the moon takes a little longer than 29 days and a little less than 30 days.

- If the moon took less than 30 and more than 29 days, what would the time be if the cycles were all the same?
  ✔ Get at the idea of 29-1/2 days.

- In a 29-day cycle, how many days would there be between the first quarter, the full moon, the third quarter, and the new moon?
  ✔ 7-1/4 days.

- In a 30-day cycle, how many days would there be between the first quarter, the full moon, the third quarter, and the new moon?
  ✔ 7-1/2 days.

- In a 29-1/2 day cycle, how many days would there be between these phases of the moon?
  ✔ 7-3/8 days.

4. **Have the students verify their findings.**

Have them

- Predict the day beginning each of the phases in the coming moon cycle.

- Predict the day of the next new moon.

- Verify their predictions during the next cycle by observing the moon.

5. **Have the students discuss, observe, and test to discover answers to questions about the moon.**

   Include such questions as
   - When would it be best to travel at night if you had no artificial light?
   - Does the moon cast shadows at night? During all its phases?
   - How much of the time during a cycle is the moon in the sky in the day? At night?

6. **Have the students discuss the study of the moon cycle. Record their ideas in the Connections Book.**

   Ask such questions as these:
   - Who needs to know about the moon and its phases? Why?
   - How else do people use information about the moon?

EXTENSION

- Have students investigate their own questions about the moon phases. Record their questions and answers in the Wonder and Discover Book.

DASH

MOON GRAPH
SP 3.2.7A
Page 1

Name: ____________________

Date: ____________________

GLUE

MONTH:	DATE	PHASE	(2400-0000) 12:00 AM MIDNIGHT	(0100) 1:00 AM	(0200) 2:00 AM	(0300) 3:00 AM	(0400) 4:00 AM	(0500) 5:00 AM	(0600) 6:00 AM	(0700) 7:00 AM	(0800) 8:00 AM	(0900) 9:00 AM	(1000) 10:00 AM	(1100) 11:00 AM	(1200) 12:00 PM	(1300)

DASH

MOON GRAPH
SP 3.2.7A
Page 2

Name: ____________________

Date: ____________________

GLUE

Directions: You will need 2 copies of pages SP 3.2.7A–1 and SP 3.2.7A–2 for each month. The numbers in parentheses stand for military or 24-hour time.

GLUE

(1300) 1:00 PM
(1400) 2:00 PM
(1500) 3:00 PM
(1600) 4:00 PM
(1700) 5:00 PM
(1800) 6:00 PM
(1900) 7:00 PM
(2000) 8:00 PM
(2100) 9:00 PM
(2200) 10:00 PM
(2300) 11:00 PM
(2400-0000) 12:00 AM MI[illegible]GHT

DASH

MOON PREDICTIONS
SP 3.2.7B

Name: ______________________

Date: ______________________

CYCLE	DATES							
	NEW MOON		FIRST QUARTER		FULL		THIRD QUARTER	
	PRED	OBS	PRED	OBS	PRED	OBS	PRED	OBS
1								
2								
3								
4								
5								
6								

How many days between new moons?

Cycle 1 and 2	Cycle 2 and 3	Cycle 3 and 4	Cycle 4 and 5	Cycle 5 and 6

How many days between phases?

CYCLE	NEW TO 1st Q	1st Q TO FULL	FULL TO 3rd Q	3rd TO NEW
1				
2				
3				
4				
5				
6				

3.2.8 POLAR SKY MODEL

OBJECTIVES

The students
- Make a polar sky model.
- Identify the constellations in the polar region.
- Develop a working definition for constellation.

BACKGROUND

This activity provides students with a tool to begin the study of the stars. It is followed by Activity 3.2.9 POLAR CONSTELLATIONS. The students make the cap of a planetarium that will be completed in grade four when they identify the constellations that move around the polar star.

Two sizes of polar caps are provided. The large model is used for class and small-group activities. The students should have their own copy of SP 3.2.8B SMALL POLAR SKY MODEL to use at home. Print them on card stock to increase durability. The student model should be fastened with a paper clip that can be removed so the model can be carried easily and stored flat.

The polar sky model is used to anticipate the location of the stars. Leave the white outside margins blank. These will be filled in when the students do Activity 3.2.9 POLAR CONSTELLATIONS.

STUDENT ROLE

Astronomer

MATERIALS

scissors
glue
paper clips
Working Dictionary
Student Pages 3.2.8A LARGE POLAR SKY MODEL
3.2.8B SMALL POLAR SKY MODEL

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PRODUCTS

Polar sky models
Completed Student Pages

PROCEDURES

1. **Introduce the activity of studying the night sky to the students. Have each group make a polar sky model. Use SP 3.2.8A LARGE POLAR SKY MODEL.**

   Have them
   - Lay out the pages.
   - Trim and then glue the pages together.
   - Shape their models into a cap.

2. **Have the student groups study their polar sky models.**

   Have them
   - Look at the inside of the model.
     ✔ It is found at the center of the cap.
   - Locate the Little Dipper or Ursa Minor.
     ✔ Polaris is the last star in the handle of the Little Dipper.
   - Locate the Big Dipper in Ursa Major.
     ✔ The Big Dipper is located close to the bowl of the Little Dipper.
   - Locate the pointer stars at the front edge of the Big Dipper and see how they are aligned with the North Star.
   - Locate other constellations shown on the model.
     ✔ Work to the idea that it is a group of stars that have been given a name. Most constellation names are based on Roman and Greek mythology.
   - Develop a Working Definition for constellation. Record it in the Working Dictionary.

3. **Have the students make their own models using SP 3.2.8B SMALL POLAR SKY MODEL.**

1026

Have them
- Cut out the model.
- Use a paper clip to fasten it together.
- Find Polaris and the Dippers.

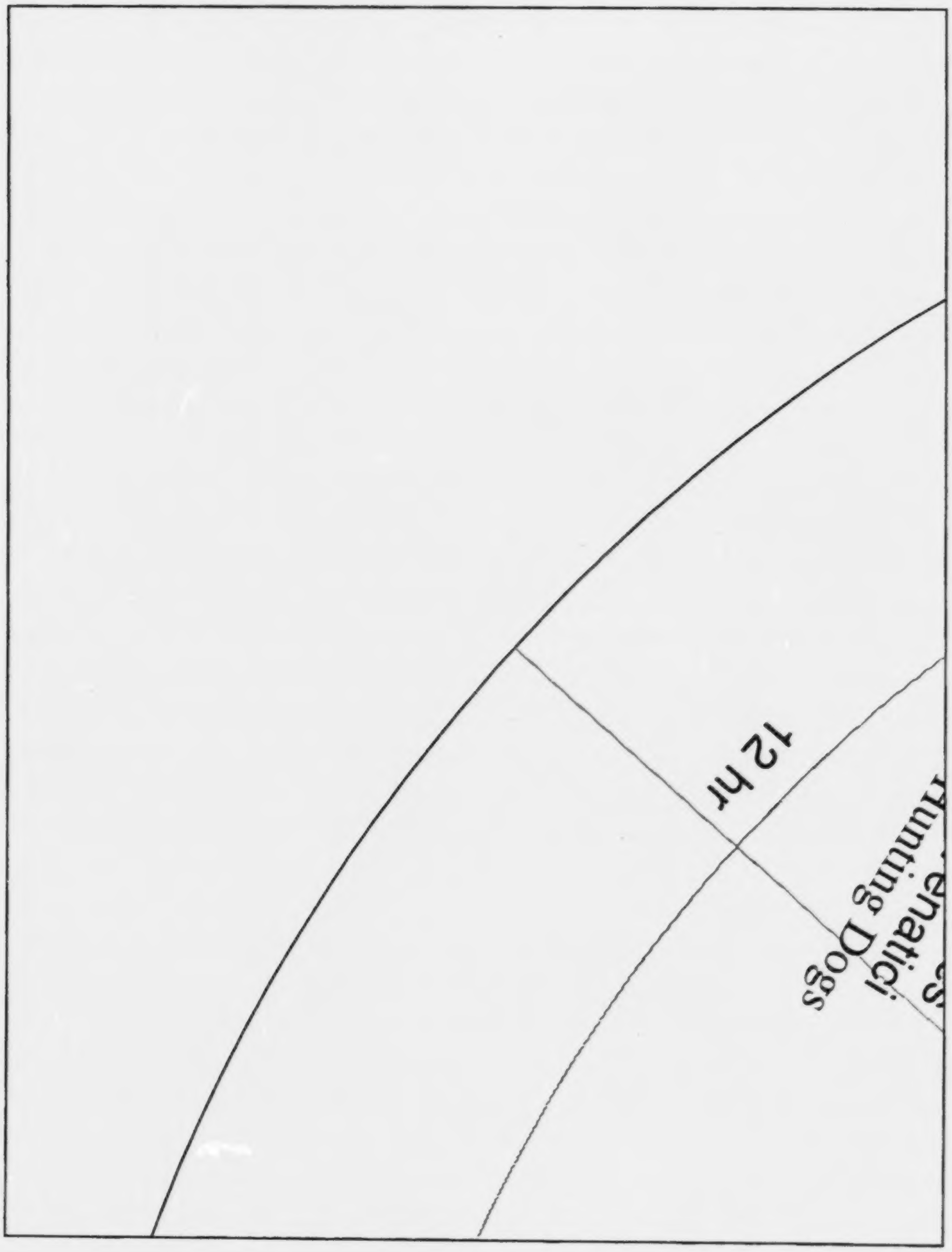
EXTENSION

- Have students research the stories about the constellations.

LARGE POLAR SKY MODEL
SP 3.2.8A Page 1

Name: ______________________

Date: ______________________

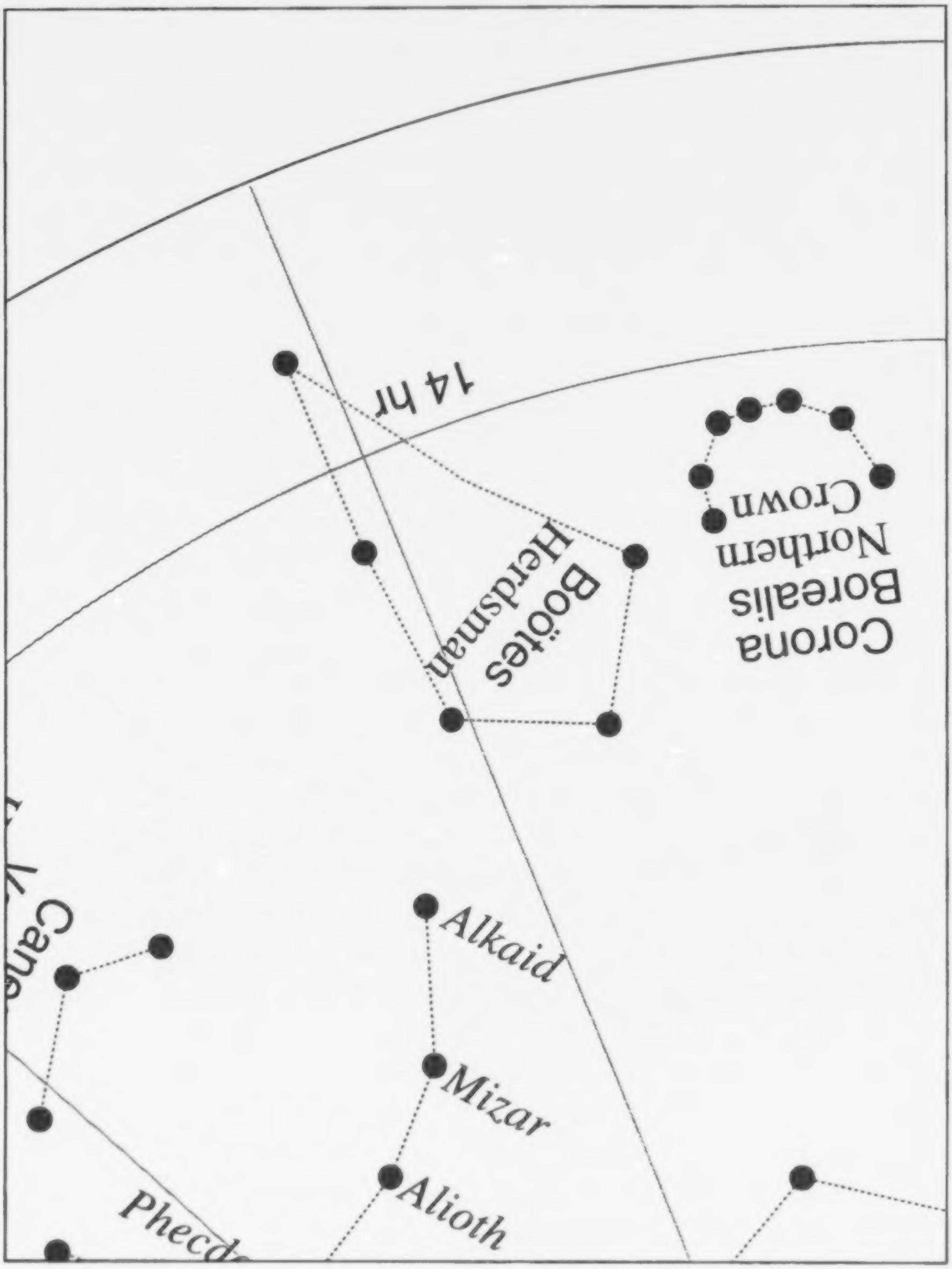

12 hr
enatici
Hunting Dogs

DASH

LARGE POLAR SKY MODEL
SP 3.2.8A Page 2

Name: ____________________

Date: ____________________

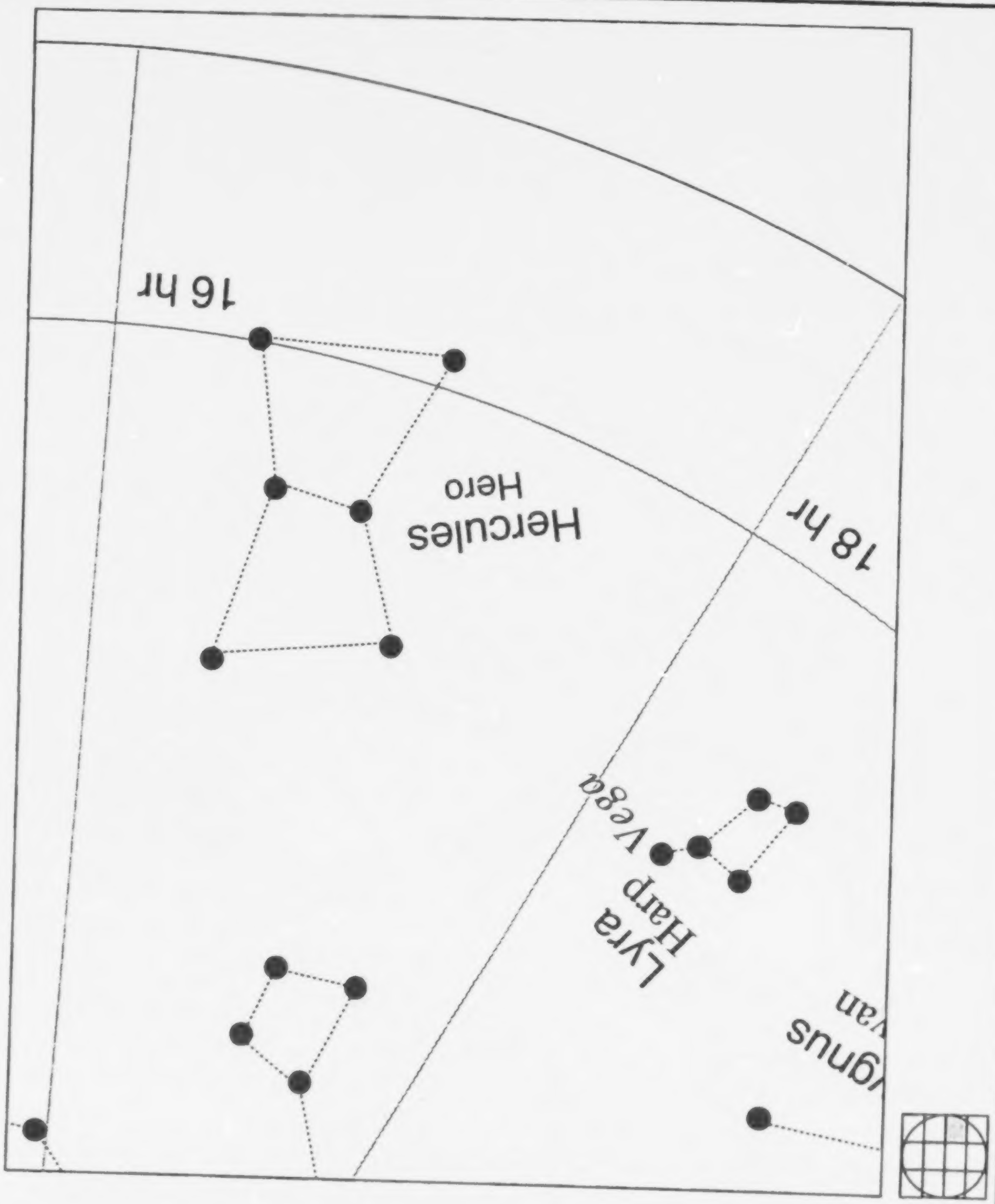

14 hr
Boötes
Herdsman
Corona
Borealis
Northern
Crown
Alkaid
Mizar
Alioth
Phecd
Cane

DASH

LARGE POLAR SKY MODEL
SP 3.2.8A Page 3

Name: ______________________

Date: ______________________

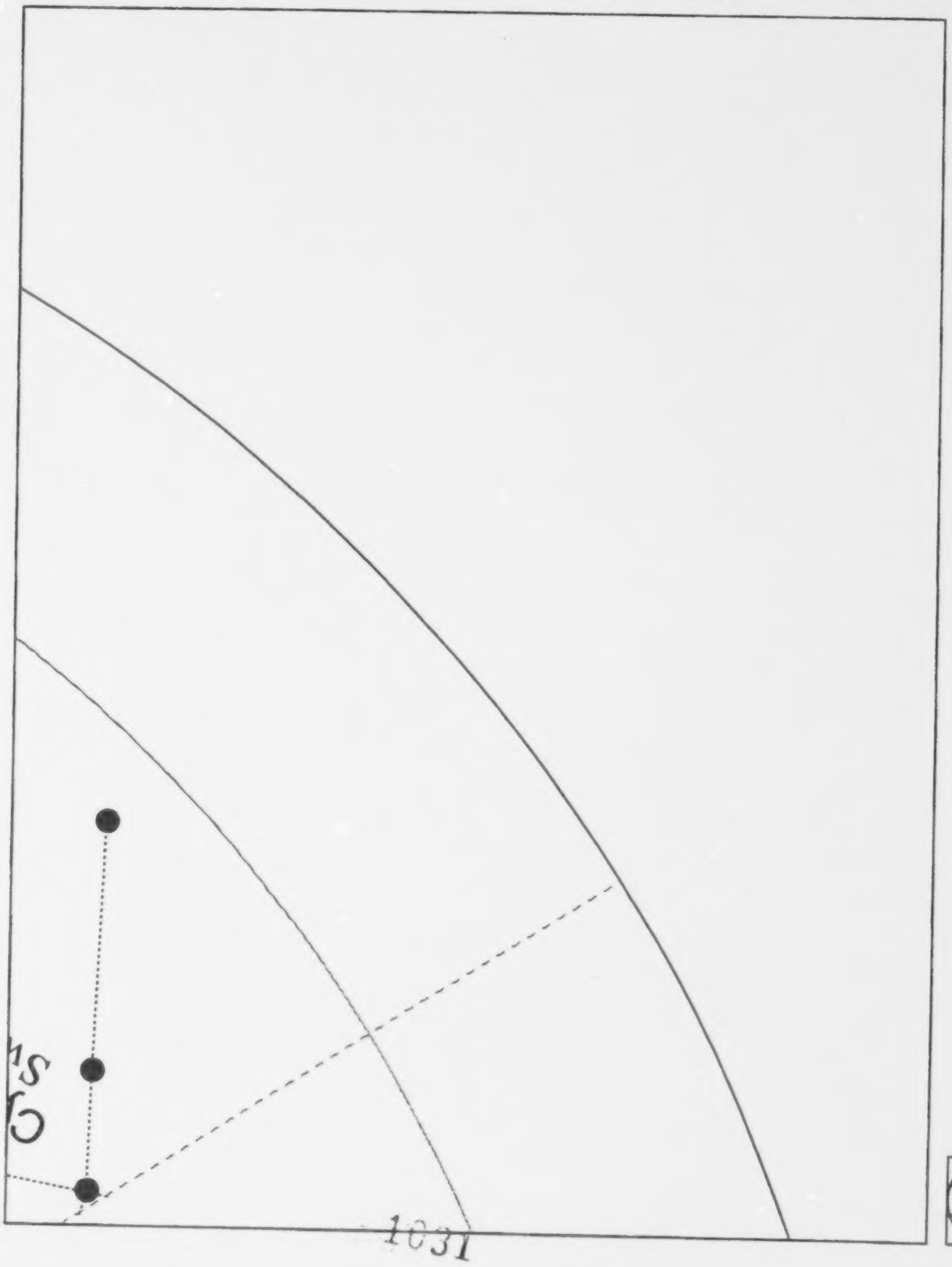

16 hr
18 hr
Hercules
Hero
Vega
Lyra
Harp
ygnus
van

DASH

LARGE POLAR SKY MODEL
SP 3.2.8A Page 4

Name: ____________________

Date: ____________________



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LARGE POLAR SKY MODEL
SP 3.2.8A Page 5

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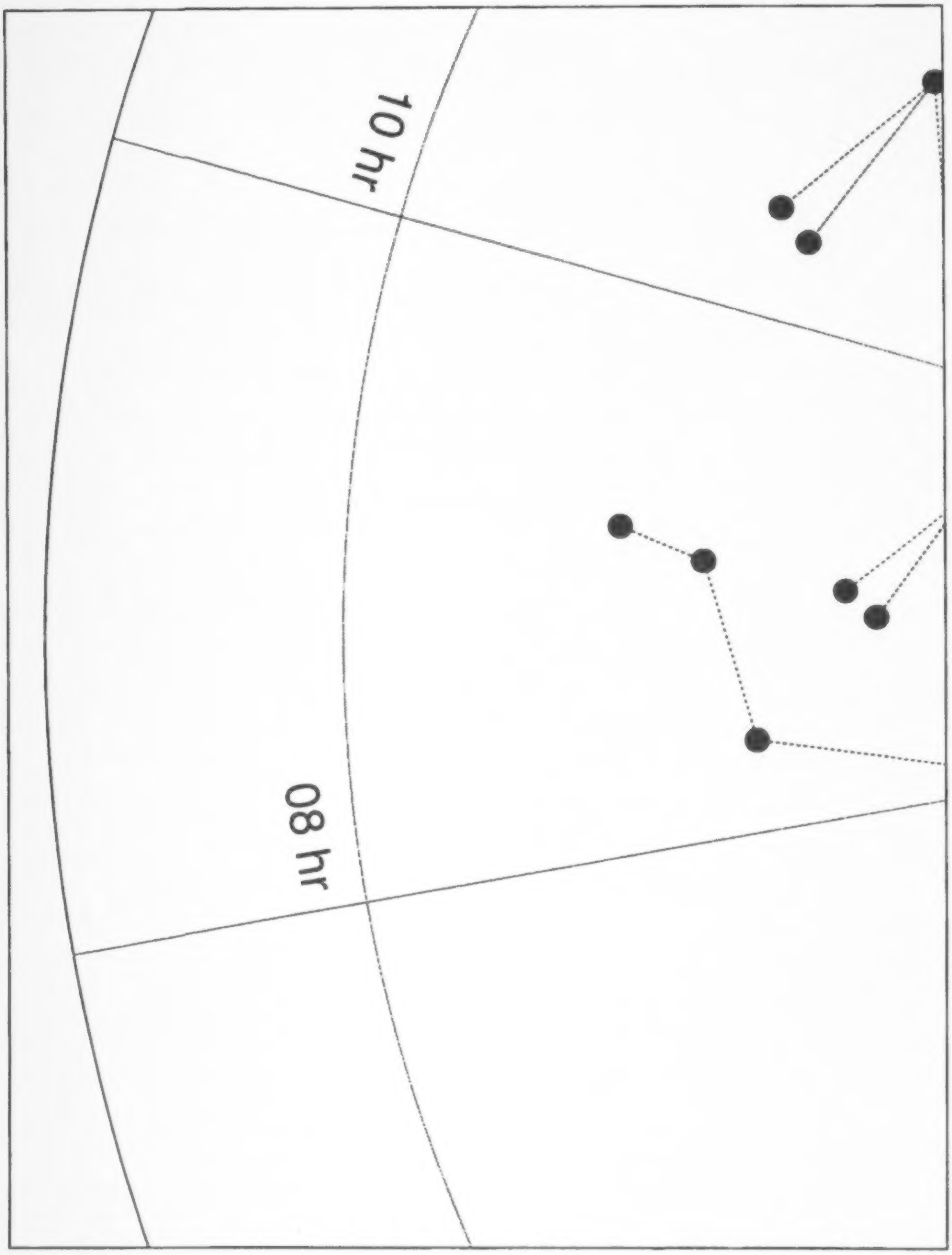
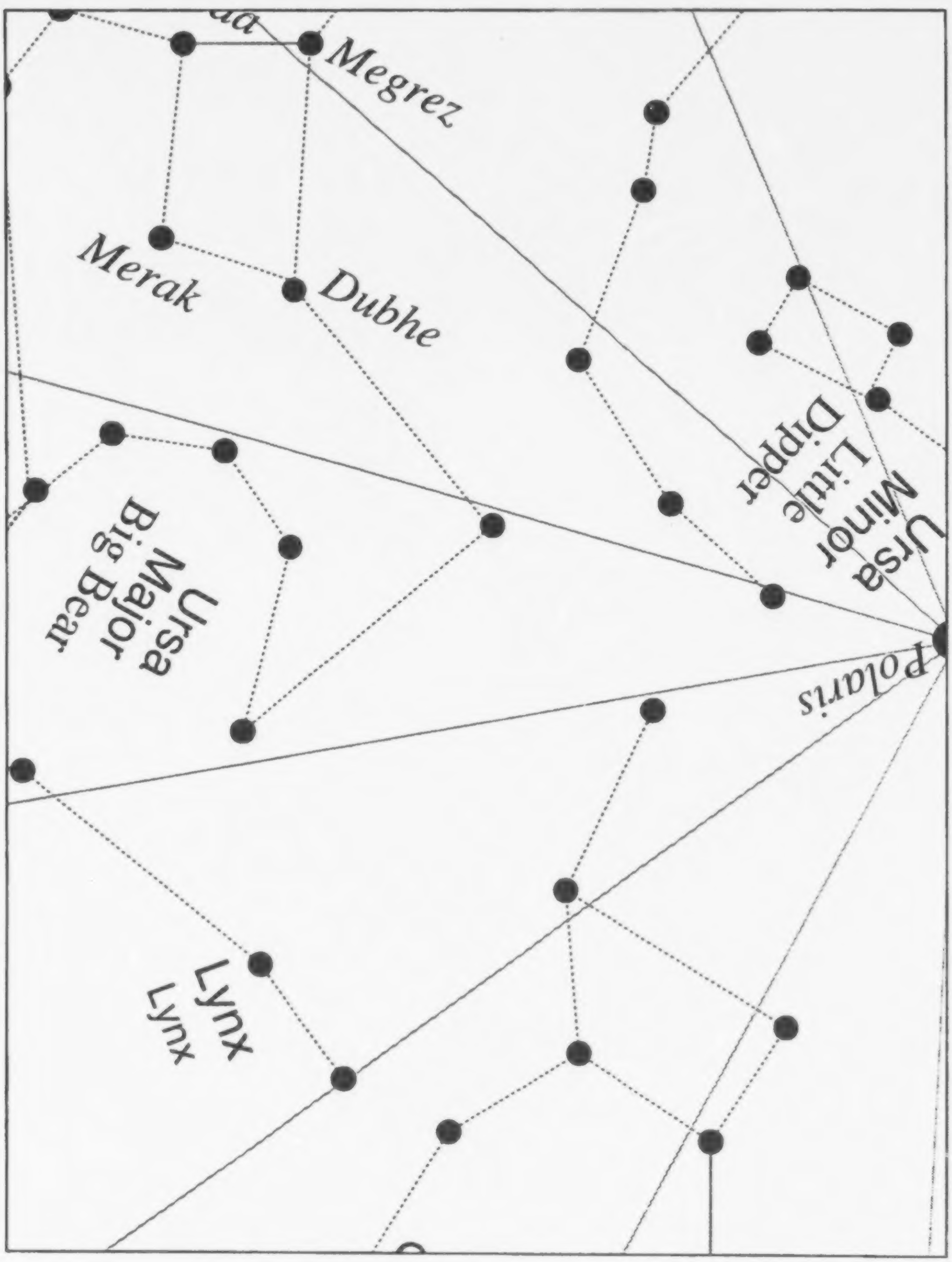
Date: ______________________



LARGE POLAR SKY MODEL SP 3.2.8A Page 6

Name: ____________________

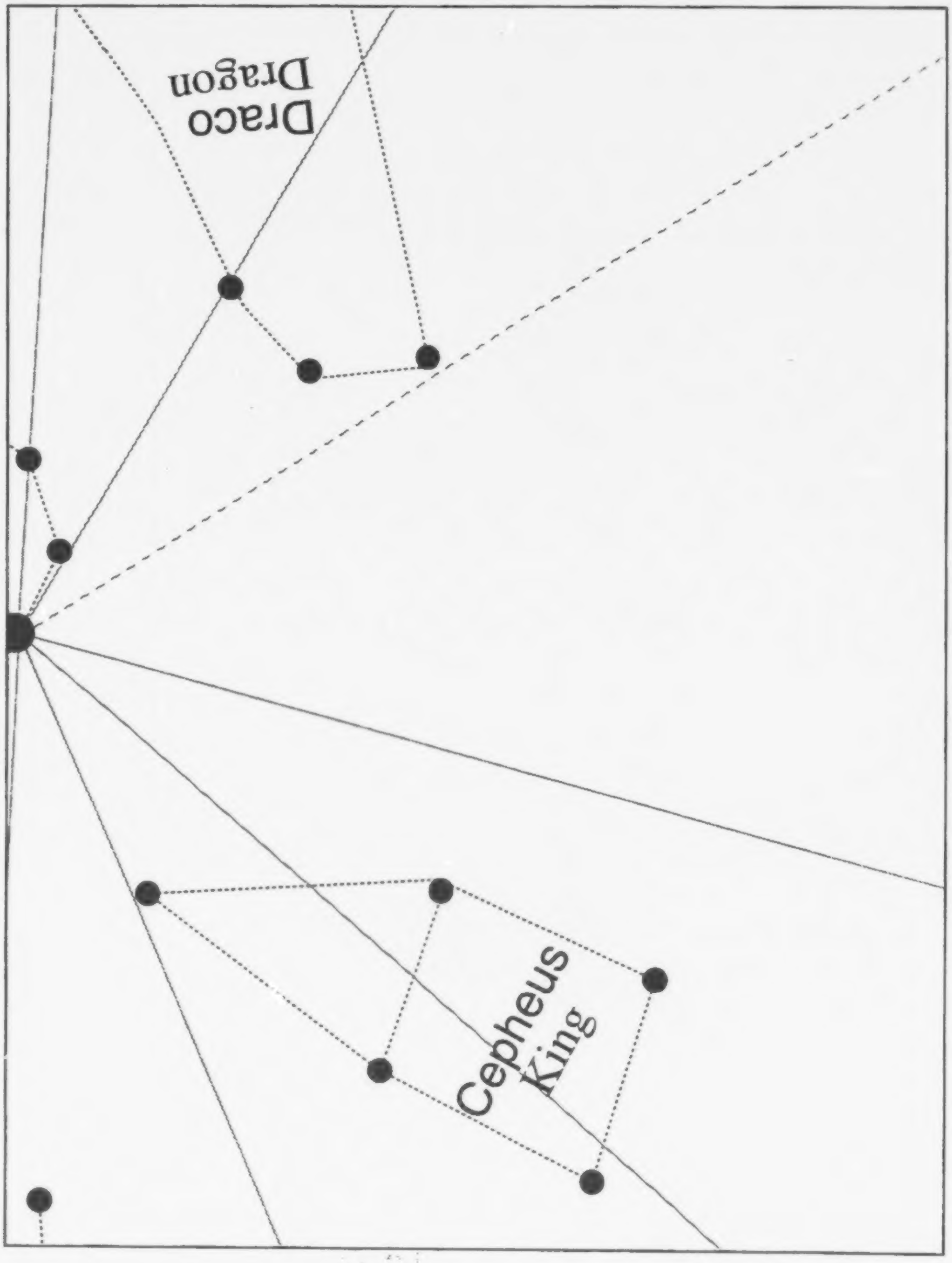
Date: ____________________


Megrez
Merak
Dubhe
Ursa Minor
Little Dipper
Ursa Major
Big Bear
Polaris
Lynx
Lynx

LARGE POLAR SKY MODEL
SP 3.2.8A Page 7

Name: ______________________

Date: ______________________

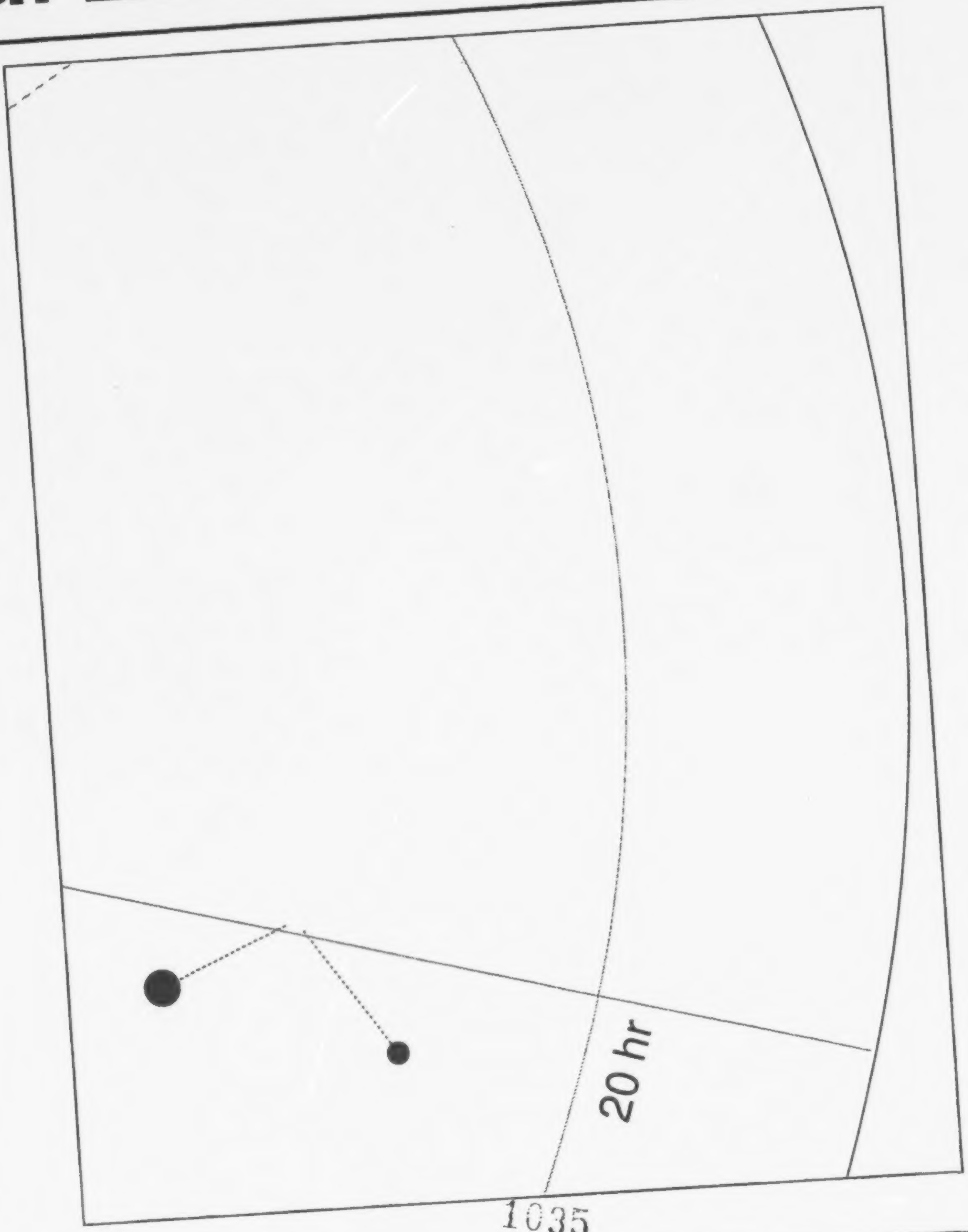

Draco
Dragon
Cepheus
King

DASH

LARGE POLAR SKY MODEL
SP 3.2.8A Page 8

Name: ______________________________

Date: ______________________________



DASH

LARGE POLAR SKY MODEL
SP 3.2.8A Page 9

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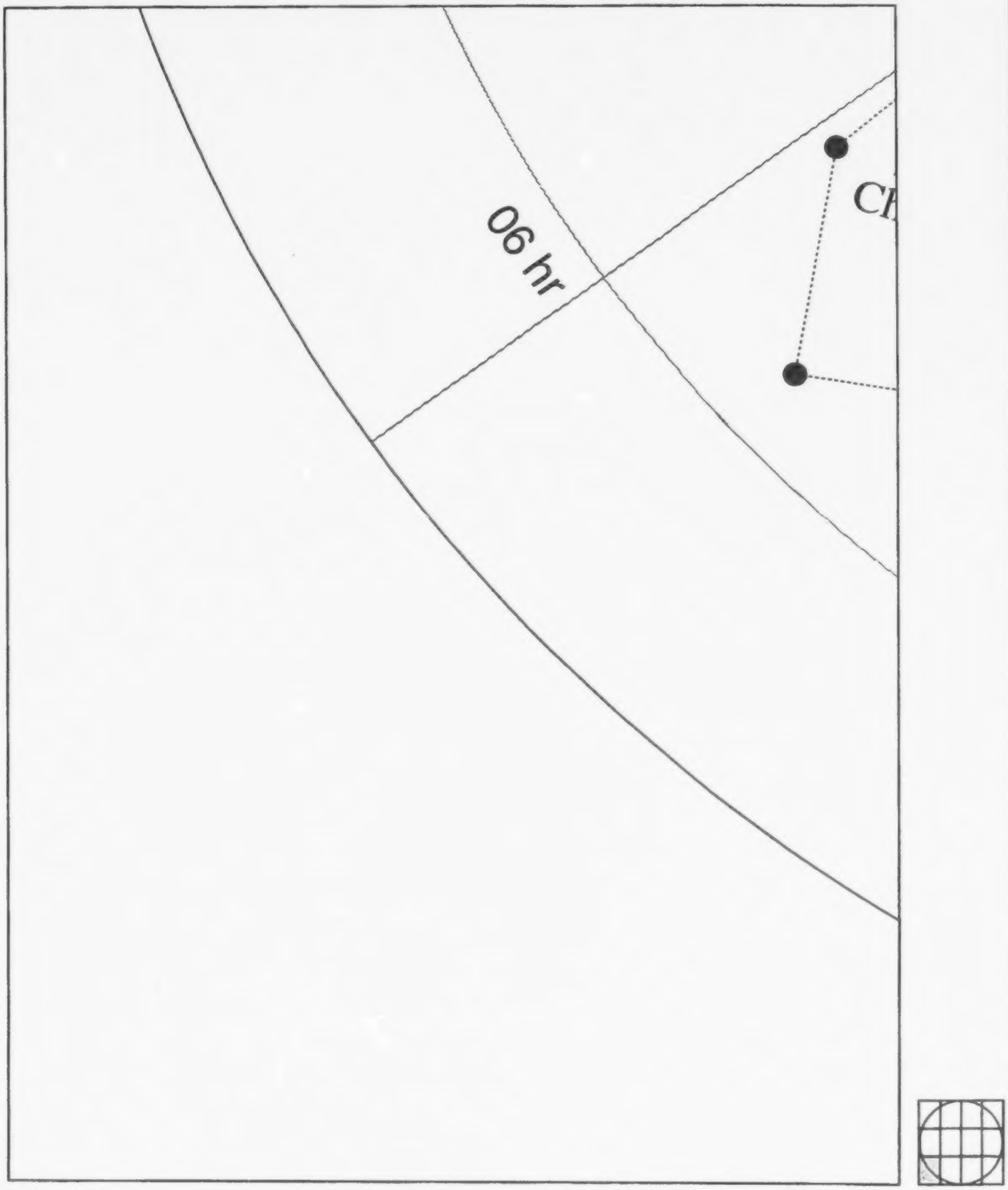
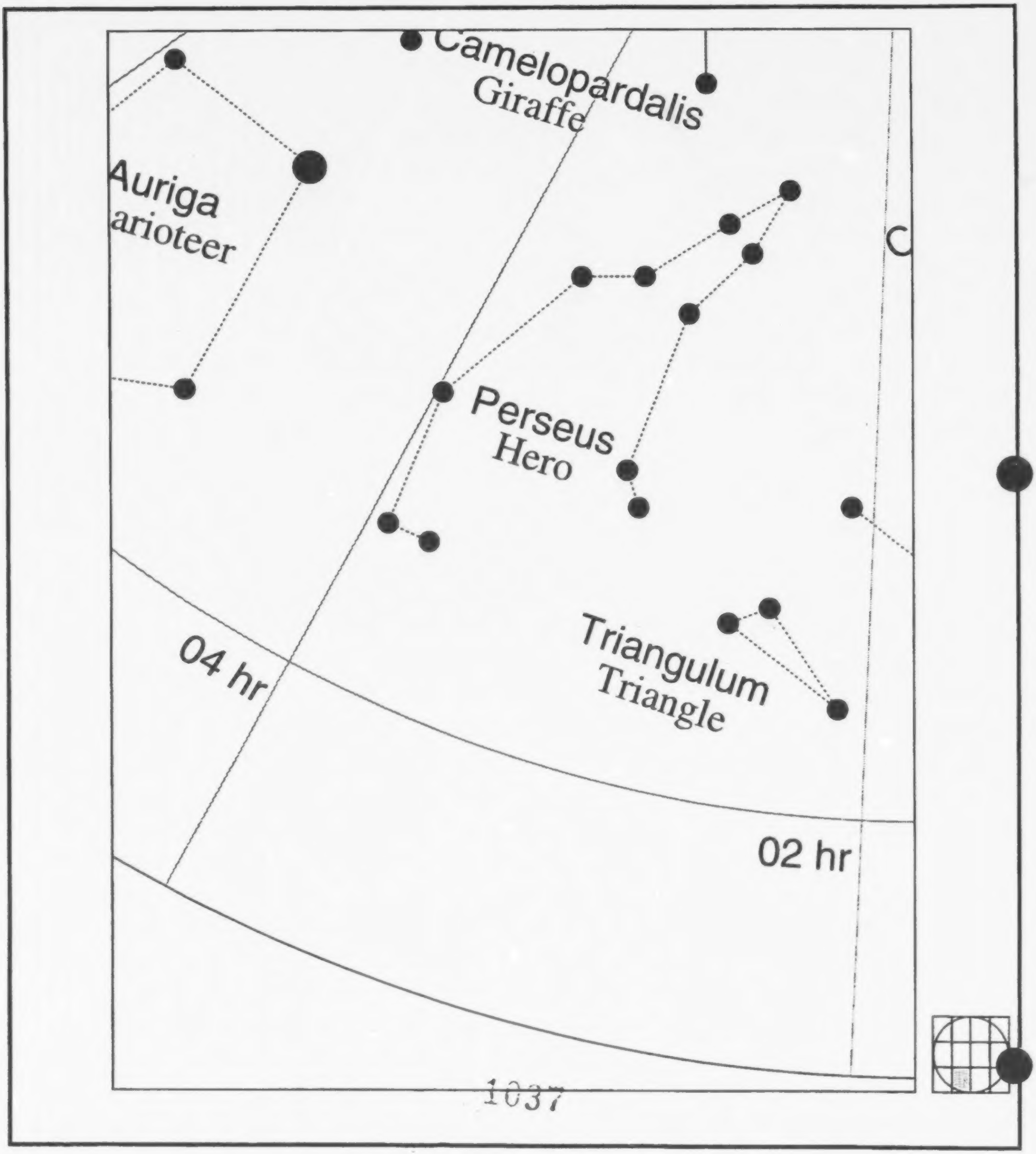
Date: ______________________



LARGE POLAR SKY MODEL
SP 3.2.8A Page 10

Name: ____________________

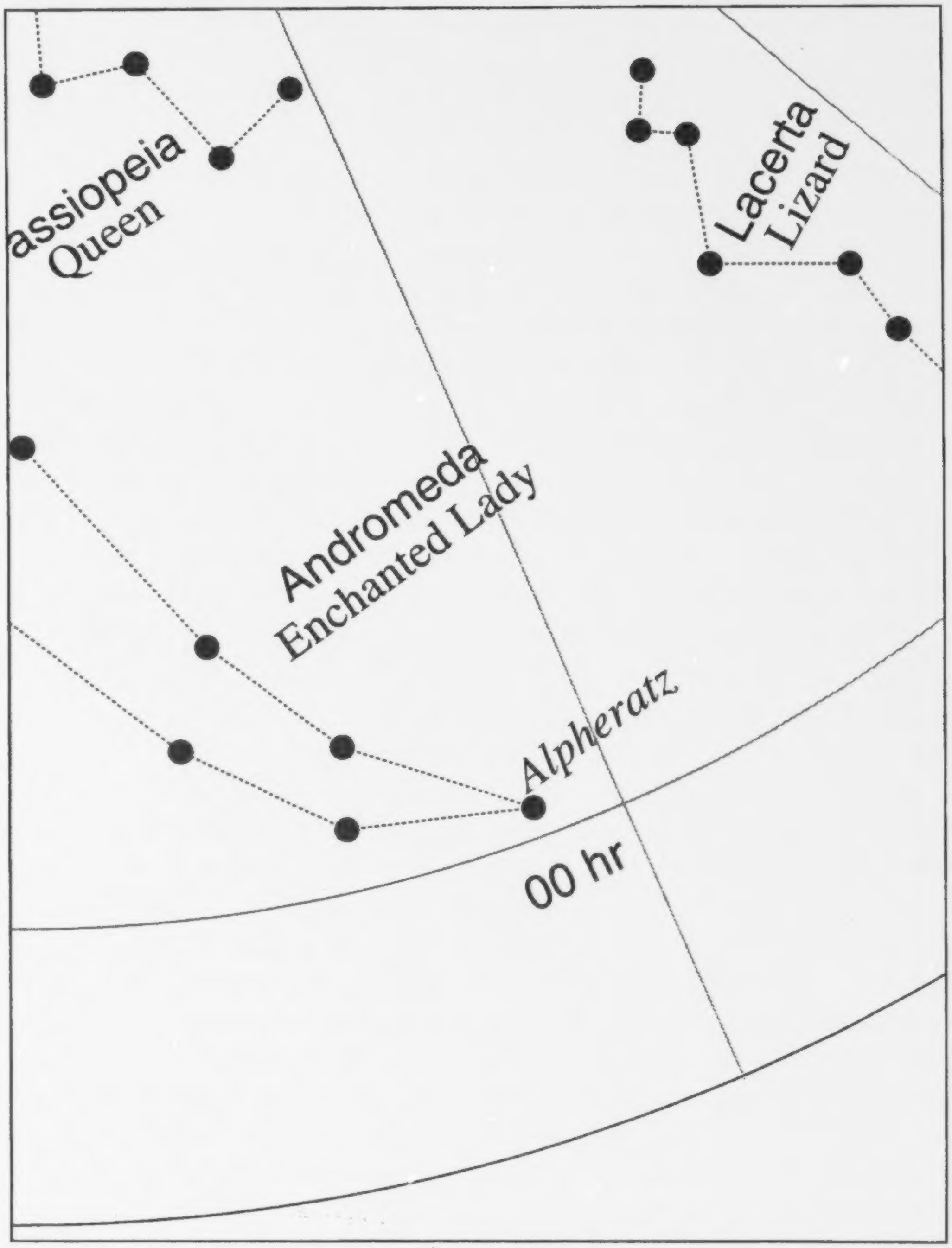
Date: ____________________


Camelopardalis
Giraffe
Auriga
arioteer
Perseus
Hero
Triangulum
Triangle
04 hr
02 hr
C

LARGE POLAR SKY MODEL SP 3.2.8A Page 11

Name: ______________________

Date: ______________________

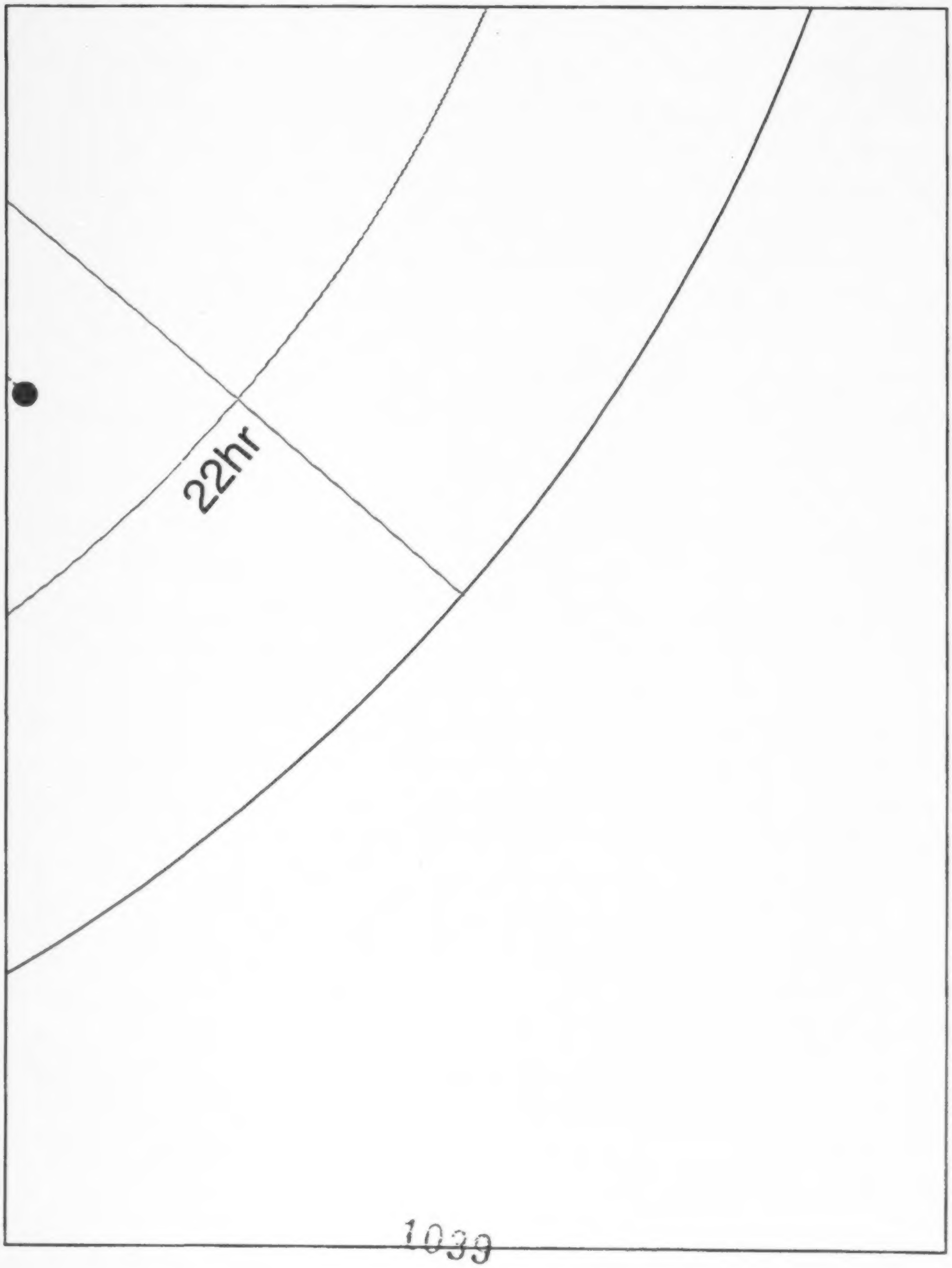


assiopeia
Queen
Lacerta
Lizard
Andromeda
Enchanted Lady
Alpheratz
00 hr

LARGE POLAR SKY MODEL
SP 3.2.8A Page 12

Name: ______________________

Date: ______________________



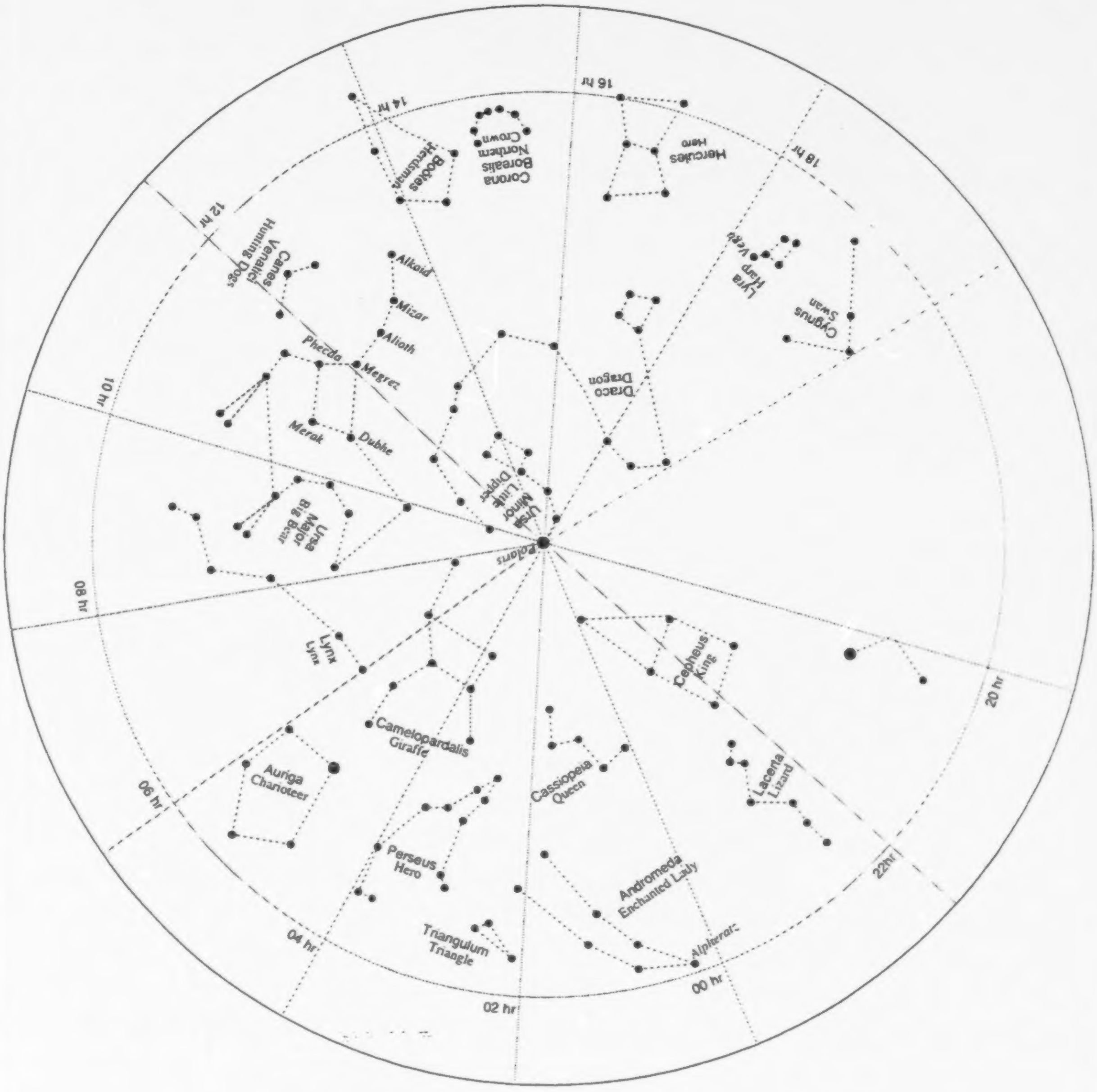
1039

DASH

SMALL POLAR SKY MODEL INSIDE VIEW SP 3.2.8B

Name: ______________________

Date: ______________________


14 hr
16 hr
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12 hr
10 hr
08 hr
06 hr
04 hr
02 hr
00 hr
22 hr
20 hr
Bootes
Herdsman
Corona Borealis
Northern Crown
Hercules
Hero
Canes Venatici
Hunting Dogs
Alkaid
Mizar
Alioth
Phecda
Megrez
Merak
Dubhe
Lyra
Harp
Vega
Cygnus
Swan
Draco
Dragon
Ursa Minor
Little Dipper
Ursa Major
Big Bear
Polaris
Lynx
Lynx
Camelopardalis
Giraffe
Cepheus
King
Lacerta
Lizard
Auriga
Charioteer
Cassiopeia
Queen
Perseus
Hero
Andromeda
Enchanted Lady
Alpheratz
Triangulum
Triangle

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3.2.9 POLAR CONSTELLATIONS

OBJECTIVES

The students
- Use their polar sky model.
- Find the northern constellation in the night sky.
- Observe the apparent rotation of the constellations around the pole star.
- Identify the location of the constellations each month on their polar sky model.

BACKGROUND

This activity has the students begin to orient themselves to the night sky. In urban areas this activity will be more difficult because of city lights. Brighter stars in the major constellations of the northern sky should be visible on a clear night away from direct street or house lights. It is suggested that a letter be sent to the parents about this activity since it is to be done at home.

An observation in the early evening shortly after twilight and another right before dawn will give a view of all of the polar constellations in the night sky. This activity is done as an inquiry activity to allow the students to discover as much as they can on their own. The activity should be started in good weather, probably in the late fall or early spring when the nights are reasonably long and warm. The best viewing is when the moon is not in the night sky. The poorest viewing is when the moon is full.

STUDENT ROLE

Astronomer

MATERIALS

Polar sky models (See Activity 3.2.8 POLAR SKY MODEL.)
Working Dictionary
Student Pages 3.2.9A POLAR CONSTELLATIONS
3.2.9B SMALL POLAR SKY MODEL OUTSIDE VIEW

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PRODUCT

Completed Student Pages

PROCEDURES

1. **Help the students learn to orient their polar sky models so they can find the polar constellations in the night sky.**

Have them
- Face north using their body as a compass.
- Check their orientation using the body compass mnemonic or the direction song.

Right rising
east.
Left leaving
west.
Nose north.
Seat south.

The sun is rising in the east,
the east, the east.
The sun is setting in the west,
the west, the west.
My nose is north.
My seat is south.
And I can turn myself about.
The sun is rising in the east and
setting in the west.

- Hold the sky model so they are looking into the cap.
- Discuss how they could find north at night.
  ✔ True north will be along the line made by their body and the North Star. Help them to find the Dippers and the North Star at the end of the handle of the Little Dipper on the model. Point out that the front two stars of the Big Dipper are in line with the polar star.
- Discuss how they could see the model when it is dark.
  ✔ They will probably need to use a small flashlight to see their model.

2. **Discuss the directions for the night observation with the class. Have the students make their observations about 8 PM.**

   Have them try to
   - Find the Big and Little Dippers.
   - Find the North Star.
   - Find where the Little Dipper is located in relation to the North Star.
     ✔ It will be above, below, or to the east or west side.
   - Find where the Big Dipper is in relation to the North Star.
     ✔ It will be above, below, or to the east or west side.

3. **Discuss the first night observation with the class. Repeat the night observation and discussion if the students have trouble finding the Dippers and the North Star.**

   Ask such questions as these:
   - Did anyone find the North Star?
   - Can you describe how you found it?
   - What time did you make your observation?
   - What problems did you have?
   - Did anyone else have that problem? How did you solve it?
   - Did anyone find the Little Dipper?
   - Can you describe how you found it?
   - What time did you make your observation?
   - Where was the Little Dipper located in relation to the North Star?

The Little Dipper at 8 PM	
Month	Location
September	The Little Dipper is west of the North Star.
October	The Little Dipper is west and below the North Star.
November	The Little Dipper is west and below the North Star.
December	The Little Dipper is below the North Star.
January	The Little Dipper is below the North Star.
Feburary	The Little Dipper is east and below the North Star.
March	The Little Dipper is east of the North Star.
April	The Little Dipper is east of the North Star.
May	The Little Dipper is east and above the North Star.
June	The Little Dipper is above the North Star.

- What problems did you have?
  ✔ Have the students solve each other's problems as possible.
- Did anyone find the Big Dipper?
- Can you describe how you found it?
- What time did you make your observation?
- Where was the Big Dipper located in relation to the North Star?

The Big Dipper at 8 PM	
Month	Location
September	The Big Dipper is west and below the North Star.
October	The Big Dipper is below the North Star.
November	The Big Dipper is below the North Star.
December	The Big Dipper is east and below the North Star.
January	The Big Dipper is east of the North Star.
Feburary	The Big Dipper is east of the North Star.
March	The Big Dipper is east and above the North Star.
April	The Big Dipper is above the North Star.
May	The Big Dipper is above the North Star.
June	The Big Dipper is west and above the North Star.

- What problems did you have?
  ✔ Have the students solve each other's problems as possible.

- Did anyone use the model to help find the North Star and the Dippers? How did you use it?

4. **Have the students mark the month in the white space on the edge of their models to represent the night sky at 8 PM.**

   Have them
   - Orient their models toward the north.
   - Indicate the directions east and west.
   - Turn their models so the Dippers are located where they saw them at 8 PM.
   - Write the month that the observation was made in the space on their models directly above the North Star.

5. **Discuss the directions for the morning observation with the class. Have the students make their observations about 5 AM.**

   Have them
   - Find the Big and Little Dippers.
   - Find the North Star.
   - Find where the Little Dipper is located in relation to the North Star.
     ✔ It will be above, below, or to the east or west side.
   - Find where the Big Dipper is in relation to the North Star.
     ✔ It will be above, below, or to the east or west side.

6. **Discuss the results of the morning observation with the class. Repeat as necessary if the students have trouble making observations.**

   Ask such questions as these:
   - Did anyone find the North Star?
   - How did you find it?
   - What time did you make your observation?

- What problems did you have?
  ✔ Have the students solve each other's problems.
- Did anyone find the Little Dipper?
- Can you describe how you found it?
- What time did you make your observation?
- Where was the Little Dipper located in relation to the North Star?

The Little Dipper at 5 AM

Month	Location
September	The Little Dipper is east and above the North Star.
October	The Little Dipper is east of the North Star.
November	The Little Dipper is east of the North Star.
December	The Little Dipper is east and above the North Star.
January	The Little Dipper is above the North Star.
Feburary	The Little Dipper is west and above the North Star.
March	The Little Dipper is west and above the North Star.
April	The Little Dipper is west of the North Star.
May	The Little Dipper is west and below the North Star.
June	The Little Dipper is west and below the North Star.

- What problems did you have?
  ✔ Have the students solve each other's problems.
- Did anyone find the Big Dipper?
- Can you describe how you found it?
- What time did you make your observation?
- Where was the Big Dipper located in relation to the North Star?

The Big Dipper at 5 AM	
Month	Location
September	The Big Dipper is east of the North Star.
October	The Big Dipper is east and above the North Star.
November	The Big Dipper is east and above the North Star.
December	The Big Dipper is above the North Star.
January	The Big Dipper is west and above the North Star.
Feburary	The Big Dipper is west and above the North Star.
March	The Big Dipper is west of the North Star.
April	The Big Dipper is west and below the North Star.
May	The Big Dipper is below the North Star.
June	The Big Dipper is below the North Star.

- What problems did you have?
  ✔ Have the students solve each other's problems.

- Did anyone use the model to help find the North Star and the Dippers? How did you use it?

7. **After general agreement has been reached by the students about the position of the Dippers at 8 PM and 5 AM, have them use the model to observe the apparent movement of the sky during a twenty-four-hour day.**

Have the students

- Hold their models so the North Star is pointing north.

- Hypothesize how the Dippers move in the sky to get from their 8 PM position to their 5 AM position.

- Hypothesize how the stars **above** the North Star move during the period from 8 PM to 5 AM.

- Hypothesize how the stars **below** the North Star move during the period from 8 PM to 5 AM.

- Hypothesize whether there are stars that stay in the northern sky all night long. If so, which stars are they?

- Work in small groups to decide how they can test their hypotheses.

- Test their hypotheses and report on their results.

- Work to agreement on the movement of the stars.
  ✔ While facing north, the stars appear to move counterclockwise; those above the North Star move east to west and those below the North Star move west to east.

- Work to agreement as to which of the stars are still visible in the morning.
  ✔ These include the North Star and the stars near it, including those in the Little Dipper. They also include the stars on or near the eastern horizon at 8 PM. These will be almost ready to set at 5 AM.

8. **Each month have a sky watch to locate the position of the Dippers at 8 PM and 5 AM. Have the students mark the month above the 8 PM position of the stars on their polar sky models.**

   Have them
   - Hold their models toward the north.
   - Turn their models so that the dippers are in the same place they saw them at 8 PM.
   - Mark the month on the blank edge of the model directly above the North Star.

9. **Summarize the polar sky observations with the class at the end of the school year.**

   Ask such questions as these:
   - How do the stars in the northern sky appear to move?
     ✔ Work to agreement that they move counterclockwise around the North Star.
   - How does the 8 PM position of the Big Dipper move each month?
     ✔ Work to an agreement that it moves in a counterclockwise direction changing just a little each month.
   - What do you think will happen to the movement of the 8 PM position of the Big Dipper during the summer?
     ✔ Have the students use Student Page 3.2.9A POLAR CONSTELLATIONS to record their predictions.

10. **Have the students revise their Working definition of constellations and record it in their Working Dictionary.**

EXTENSIONS

- Have the students locate other constellations that are easy to distinguish such as Cassiopeia and Orion. Have them observe the apparent movement of these constellations.
- Have the students find diagrams of the people, creatures, and things seen by the ancients in the constellation of the northern sky. Use SP 3.2.9B SMALL POLAR SKY MODEL OUTSIDE VIEW. This fits on the outside of the small polar sky model made in Activity 3.2.8 POLAR SKY MODEL.
- Suggest to the students interested in photography that they can take pictures of the stars by finding a dark place and leaving the shutter of the camera open for an hour or more.

DASH

POLAR CONSTELLATIONS SP 3.2.9A

Name: ______________________

Date: ______________________

Draw the Big Dipper where you predict it will be located in June, July, and August. Label each drawing with the month. When you make your observation, draw the Big Dipper in another color and label with the date of your observation.

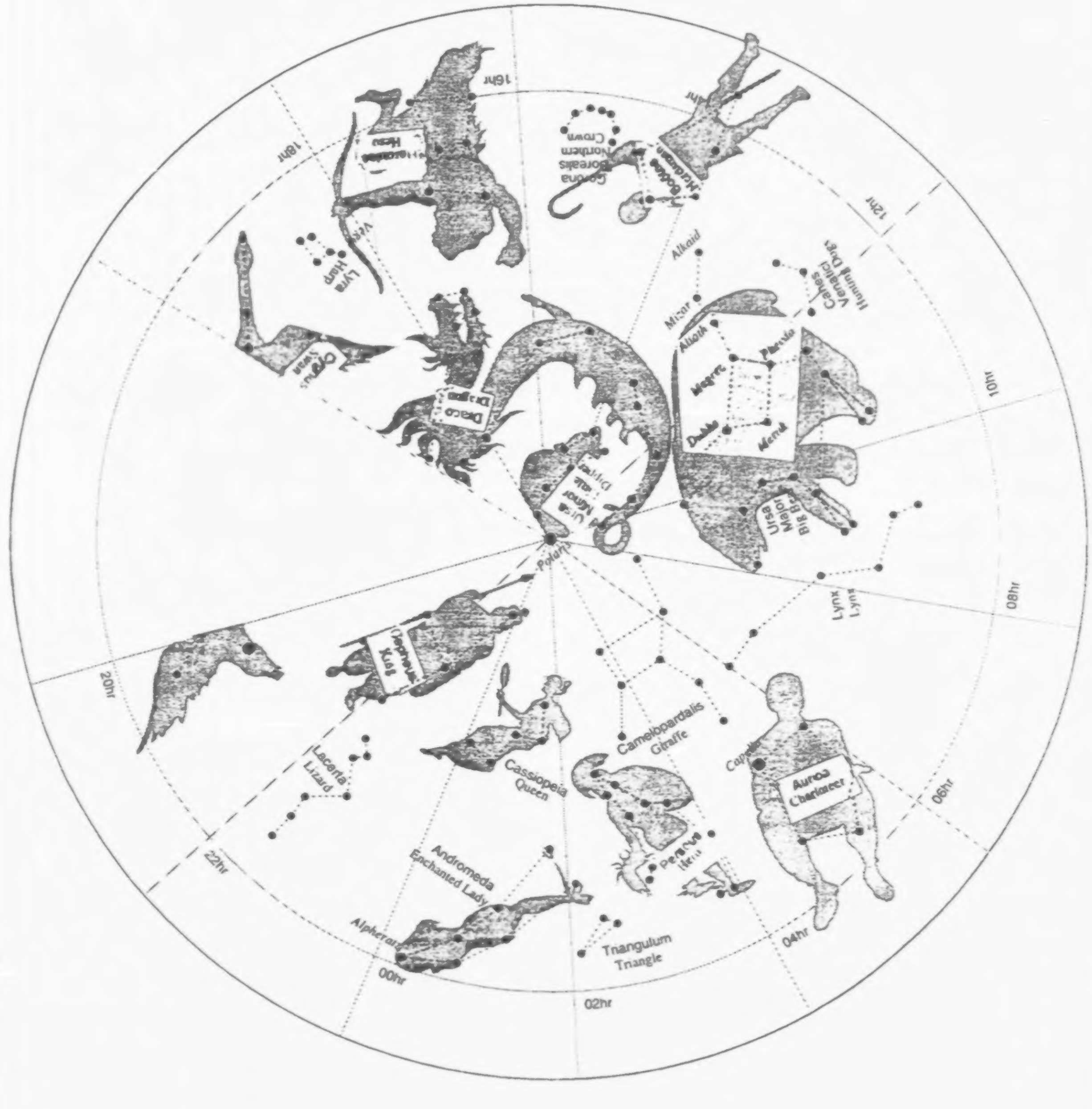
★ North Star

DASH

SMALL POLAR SKY MODEL OUTSIDE VIEW SP 3.2.9B

Name: ______________________

Date: ______________________


16hr
18hr
Hercules
Hero
Corona
Borealis
Northern
Crown
Bootes
Herdsman
12hr
Vega
Lyra
Harp
Cygnus
Swan
Draco
Dragon
Alkaid
Mizar
Alioth
Megrez
Phecda
Dubhe
Merak
Canes
Venatici
Hunting Dogs
10hr
Ursa
Minor
Little
Dipper
Ursa
Major
Big Bear
Polaris
Lynx
Lynx
08hr
20hr
Cepheus
King
Lacerta
Lizard
Cassiopeia
Queen
Camelopardalis
Giraffe
Capella
Auriga
Charioteer
06hr
22hr
Andromeda
Enchanted Lady
Perseus
Hero
Alpheratz
00hr
Triangulum
Triangle
04hr
02hr

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3.2.11 ECLIPSES

OBJECTIVES

The students
- Build a camera obscura or other sun-viewing device.
- Use the sun-viewing device to observe, draw, and time solar eclipses.
- Invent ways to observe, draw, and time eclipses of the moon.
- Create a working definition for eclipse.

BACKGROUND

In this activity the students prepare to observe, draw, and time eclipses of the sun and moon. They invent and build devices to do this.

Solar eclipses are produced during a new moon when the moon passes in front of the sun. They occur during daylight hours, often during school time. A **total eclipse**, the alignment of the sun and the moon so that the sun is completely blocked, is rare.

Partial eclipses in which the moon covers only part of the sun are relatively common. During the years students are in elementary school they will have several opportunities to observe partial eclipses. To observe the moon fully covering the sun, a person on earth must be in direct alignment with the sun and the moon. The path of proper alignment is quite narrow. Observers on either side of the path see a partial eclipse. Information on when and where eclipses will occur is found in almanacs, newspapers, science magazines, and the CRDG Science Newsletter.

Lunar eclipses occur during a full moon when the earth passes between the sun and the moon. They happen at night. Though more common than total solar eclipses, alignment of the sun, earth, and the moon for a total eclipse of the moon is relatively rare. Partial lunar eclipses are common. One technique to view an eclipse of the sun is to use a camera obscura. DASH students use this invention in grade two to observe the sun. The camera obscura is a pinhole camera that provides a sharp image. The longer the box used to make the camera is, the larger the image will be. The sun casts an image on the back of the camera that can be traced on paper. By using a large box students

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can put their head and hands inside it for viewing and drawing. It is important to keep all light out of the camera except what comes through the pinhole. This is done by using a thick, dark drape over the observer and covering any light spaces with duct tape.

Alignment of the camera is left to the invention of the students. Success will occur when the camera is positioned so that the base rests along a line cast by a stick with the pinhole pointed at the sun. See Figure 3.2.11 (1).

There are other other ways that an eclipse of the sun can be viewed. **Use caution** since with some methods there is a risk that students will look directly into the sun and potentially damage their eyes.

Eclipses of the moon can be recorded in several ways. Drawings can be made on plastic or cellophane sheets taped over a mirror or onto a glass window pane using overhead projector pens. The moon's eclipses can also be photographed directly. See Figure 3.2.11 (2).

STUDENT ROLE

Astronomer

MATERIALS

large cardboard box
duct tape
thick dark cloth
pencils
paper
watch
Working Dictionary
Connections Book
Student Page 3.2.11A SOLAR ECLIPSE
Student Page 3.2.11.B LUNAR ECLIPSE

PROCEDURES

1. **Have the students construct camera obscuras for viewing and drawing the stages of an eclipse of the sun.**

2. **Have the students practice using their camera obscuras.**

   Ask such questions as these:
   - What happens to the image as the screen is moved closer to the pinhole? Further away from the pinhole?

   - How could you modify your camera to get a larger image?
   - What happens as the inside of your camera gets darker?

   - Can anyone see objects other than the sun? Can you see clouds? Trees?

   - How could you modify your camera to get an even better image of these things?

   - How did you set up your camera to get the image of the sun to fall on the back of your camera?

3. **Have the students watch the papers and look in almanacs to find out when the next solar eclipse will be visible in their geographic area.**

4. **Have the class use their camera obscuras and a watch to record a solar eclipse.**

   Have them
   - Time the eclipse from beginning to end.

   - Trace the image of the sun during the eclipse at one-minute intervals.

   - Record their data on Student Page 3.2.11A SOLAR ECLIPSE.
   - Record the phase of the moon.

5. **Review the students' experience with the solar eclipse.**

   Ask such questions as these:
   - How could you tell when the eclipse started?

   - How could you tell when the eclipse ended?

   - How long did the eclipse take?

   - How much of the sun was covered at the maximum point of the eclipse?

- How did this eclipse compare with other eclipses you have observed?

- What seems to be the relationship between an eclipse of the sun and the phase of the moon?

6. **Have student groups invent ways to view and draw the stages of a lunar eclipse.**

   Inventions may include
   - Cameras.

   - Systems using a pane of window glass or a mirror.

7. **Have the students practice using their devices before an eclipse is expected and share with the class what they have done.**

8. **Have the students watch the papers and look in almanacs to find out when the next lunar eclipse will be visible in their geographic area.**

9. **Have the class use their viewing devices and a watch to record a lunar eclipse.**

   Have them
   - Time the eclipse from beginning to end.

   - Trace the image of the moon during the eclipse at one-minute intervals.

   - Record their data on Student Page 3.2.11B LUNAR ECLIPSE.

   - Record the phase of the moon.

10. **Review the students' experience with the lunar eclipse.**

    Ask such questions as these:
    - How could you tell when the eclipse started?

    - How could you tell when the eclipse ended?

    - How long did the eclipse take?

    - How much of the moon was covered at maximum point of the eclipse?

- How did this eclipse compare with other eclipses you have observed?
- What was the phase of the moon? What seems to be the relationship between the lunar eclipse and the phase of the moon?

11. **Have the students create or refine their Working definition of eclipse and record it in their Working Dictionary.**

12. **Have the class record their ideas in the Connections Book.**

Ask such questions as these:

- Where else have you seen eclipses?
- Who else records information about eclipses?
- What could be learned by observing eclipses?
- Why might this information be important? Who might need to use this information?

EXTENSIONS

Have the students

- Read about how eclipses were viewed by people in ancient times.
- Find articles about why research scientists study eclipses.

DASH

SOLAR ECLIPSE
SP 3.2.11A

Name: ____________________

Date: ____________________

Draw and label your camera obscura.

Copy or glue your drawings of the solar eclipse. Put the time under each drawing.

Describe or draw and label how you think the sun, the moon, and the earth are positioned at the time of a solar eclipse.

DASH

LUNAR ECLIPSE
SP 3.2.11B

Name: ______________________

Date: ______________________

Draw and label your invention for viewing a lunar eclipse.

Copy or glue your drawings of the lunar eclipse. Put the time under each drawing.

Describe or draw and label how you think the sun, the moon, and the earth are positioned at the time of a lunar eclipse.

2.4.1 SOIL

OBJECTIVES

The students
- Collect soil samples.
- Investigate soil with a magnifying glass.
- Invent a method of drying soil.
- Invent a device to sort components by particle size.
- Measure volume and mass of soil components.

BACKGROUND

This activity follows Activities 2.10.3 THE BALANCE and 2.10.5 MEASURING VOLUME.

In SOIL the students begin their investigation of soil. First they devise a way to dry the soil without using a stove. Sun drying is suggested though students may have other ideas. Spreading the soil on a tray and breaking up large pieces will speed the process. The students then separate the soil into its different components by sifting.

Sieves

Sieves with different-sized holes can be made by using various sizes of nails and aluminum pie or cake pans. A hammer may be useful but be sure to protect the surface under the pans. Standardize the sieves by the diameter of the nails used to make the holes.

STUDENT ROLE

Agronomist

MATERIALS

chart paper
soil
half-pint milk cartons for soil samples
trowels (shovels)
magnifying glasses

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aluminum pie or cake pans (4 per group)
aluminum foil
nails (1 set per group)
  three-penny (small)
  eight-penny box nails (medium)
  twelve-penny box nails (large)
hammers (optional)
wood to pound on (if hammers are used
newspaper
balances from Activity 2.10.3 THE BALANCE
graduated containers from Activity 2.10.5 MEASURING VOLUME
goggles
Student Page 2.4.1 SOIL

PRODUCTS

Concept map about soil
Completed Student Pages

PROCEDURES

1. **Help the class make a concept map about soil. Announce that they are going to study soil.**

   Ask such questions as these:
   - What do you know about soil?
   - How is soil used?
   - What do you think soil is made of?
   - Are soil, mud, and sand the same thing?
   - Are soil and dirt the same thing?
     ✔ This question is likely to stir up quite a debate. Encourage the students to research their views. There is not complete agreement in the scientific community so there is no definitive answer to this question—and many others in science. This is the nature of science.

2. **Have the students work in groups and go outside to get two half-pint samples of soil from the same place. Set aside one sample for Activity 2.4.3 SOIL AND PLANTS. Have different groups get samples from various places. Alternately have the students bring the samples from home.**

3. **Have the students investigate the soil samples with magnifying glasses.**

   Have them
   - Pour one of the two soil samples onto newspaper.
   - List the kinds of things they find in the samples.
   - Inspect, identify, and then return any living organisms to the places they were found.
   - Report findings on Student Page 2.4.1 SOIL.
   - Add any new information to the concept map about soil.

4. **Have the students invent a way of drying soil if it is moist. Explain that to study the soil further you must invent a way to dry it. Only natural heat sources are to be used.**

   Ask such questions as these:
   - How could you dry your sample if you can't use a stove?
   - Do you know any natural heat source?
   - If you have two samples of soil the same size and roll one into a ball and place it on your hand and spread the other on your hand, which would dry more quickly?
     ✔ Work for the idea that the spread-out soil will dry more quickly. Have someone try it and see,
   - What might this tell you about drying soil quickly?
     ✔ Work for the idea of spreading soil thinly to dry it more quickly.
   - What happens to the soil when it is dry?
     ✔ Work for the idea that it breaks up into small pieces.

5. **Once the soil is dried have the students study their samples again. Have the students invent ways to granulate chunks of soil and to separate dry soil by particle size.**

   Ask such questions as these:
   - What different kinds of things did you find?
   - Are there chunks of dried soil?

- How could you break these chunks into smaller pieces?
  ✔ Work for such things a rubbing them together, putting them into a sock and hitting the sock against the floor.

- How could you separate all of the particles that are about the same size into different piles?
  ✔ If students don't come up with an idea, show the students a toy sand sifter. Ask how the device works.

- How could you make such a device?

- How can you make holes of different sizes?

- How can you make all the holes in a sieves the same size?
  ✔ Help them *only as needed* to make 3 sieves with different-sized holes. See suggested nail sizes.

6. **Have the students measure out approximately 125 mL or 1/2 cup of dry soil. Use their graduates from Activity 2.10.5 MEASURING VOLUME. Have them sort and measure the mass and volume of soil particles of different sizes.**

   Help them
   - Weigh their sample before beginning to sift. Record the mass and volume of the soil sample on SP 2.4.1 SOIL.
   - Sort the particles by sifting or other methods.
   - Weigh the amount of material of each different particle size using their balances. Record their data on Student Page 2.4.1 SOIL.
   - Measure the volume of the amount of material of each different particle size using their graduates. Record their data on the Student Page 2.4.1 SOIL.

7. **Help the students make some generalizations about soil.**

   Ask such questions as these:
   - What does soil seem to be made of?
   - Do all samples of soil contain the same things? Explain.
   - Are there the same amounts of different-sized particles in various samples of soil?

1062

- Is the sum of the masses of the different sized particles equal to the mass of your starting sample? Volumes? If not, what might have happened?
- What information should be added to or modified on the concept map about soils?

EXTENSIONS

- Set up an agronomist center where students can investigate, measure, and record the contents of additional soil samples they collect.
- Create a bulletin board display by attaching small soil samples in baggies to a neighborhood map to identify where they were collected.

SP 2.4.1

DASH

SOIL
SP 2.4.1

Name: ____________________

Date: ____________________

Where did you get your soil?

Observations:

MASS

Unit __________

Total Sample	Biggest	Medium Big	Medium Small	Smallest

VOLUME

Unit __________

Total Sample	Biggest	Medium Big	Medium Small	Smallest

2.4.2 MAKING SOIL

OBJECTIVES

The students
- Hypothesize about how rocks become soil.
- Crush rocks into soil size particles.
- Make soil from their crushed rock.
- Summarize and speculate about soil formation.

BACKGROUND

The students try to make soil from rock after they have investigated the contents of the soil samples collected in Activity 2.4.1 SOIL. Three methods are suggested. Sand can be pulverized with a hammer, rocks can be crushed with a stamp mill, and weathered or fragile rocks can be broken up by rubbing them together.

Stamp Mill

Make a stamp mill for crushing rock or borrow one from another DASH 2 or DASH 4 teacher if one is not already in the classroom. See figure 2.4.2 for construction. Caution the students not to try breaking the rocks with hammers.

Eye Protection

Eyes should be protected with goggles during this activity. Eyes can also be protected with student made face shields. This is an opportunity for the DASH 5 students to help in making shields. See Activity 2.10.6 SAFETY EQUIPMENT.

Measuring Volume and Mass

Use the procedures from Activity 2.4.1 SOIL to determine the volume and mass of the particles that are produced. The proportions of different sized particles found in Activity 2.4.1 SOIL can be used as a soil recipe.

STUDENT ROLE

Agronomist

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MATERIALS

small rocks to be crushed
large rocks to be dropped on each other
weathered rocks or sand (decomposing granite, sandstone, volcanic tuff)
stamp mill rock crusher
  30 cm (1 ft) of metal pipe 1 and 1/2-inch in diameter
  1 metal cap 1-1/2 inch in diameter
  1 meter (3 ft) of metal pipe 3/4-inch in diameter
  1 metal cap 3/4 inch in diameter
hammer for sand pulverizing only
balance
goggles
graduated containers from Activity 2.10.5 MEASURING VOLUME
balances from Activity 2.10.3 THE BALANCE
sieves from Activity 2.4.1 SOIL
newspaper
thick metal surface for pulverizing sand (a thick concrete surface can be used if hammer marks are of no concern)
Student Page 2.4.2 MAKING SOIL

PRODUCTS

Student-made soil
Completed Student Pages

PROCEDURES

1. **Review the concept map about soil with the class and introduce the problem of making soil.**

   Ask such questions as these:
   - What does soil mostly seem to be made of?
     ✔ Review the contents of the soil they have just analyzed.

   - Where do you think these particles came from originally?
     ✔ Work to the idea that they probably came from rock because they look like little rocks and rocks can be broken up to look like these particles.

   - Do you think you could make soil from rocks? What would you need to do this?

1066

- What danger is there in using a hammer to break up rocks?
  ✔ Get at the idea that rocks can fly when hit with a hammer. Show them the stamp mill and have a student demonstrate how it crushes small rocks.

- Why should you wear goggles or face protectors?

- What else did you find in the soil you analyzed in Activity 2.4.1 SOIL?

2. **Have each group come up with a soil recipe similar to one they analyzed in Activity 2.4.1 SOIL and record it on Student Page 2.4.2 MAKING SOIL. The total volume should be about 125 mL or one half cup of soil.**

   Have them include
   - Rock particle sizes and proportions.

   - Any other ingredients from their analysis that they may wish to add and their proportions.
     ✔ Do *not* add fertilizers since they are ingredients that will not have been seen in the original analysis of soil. The role of fertilizers and chemical nutrients in soil will be dealt with in later DASH work.

3 **Have the students crush small rocks and pulverize sand.**

   Help them
   - Discover how to pulverize sand using a hammer.

   - Discover how to use the stamp mill to crush small rocks.

   - Discover that rubbing weathered rocks together breaks them up.

   - Collect all pulverized materials after all team members have had a chance to work.

4. **Have student groups sort and measure the amount of soil particles of different sizes they will need to make 125 mL of artificial soil.**

   Help them
   - Sort the particles by sifting or other methods.

- Weigh or measure the amount of each particle size they put together.
  ✔ Save the sample for Activity 2.4.3 SOIL AND PLANTS.

- Record their data on Student Page 2.4.2 MAKING SOIL.

6. **Summarize and speculate about soil formation with the class.**

   Ask the students such questions as these:
   - Have you made the same kind of soil that you found outside?

   - How was the soil you made similar to and different from the soil you found outside in Activity 2.4.1 SOIL?
     ✔ Compare the proportions.

   - How might big rocks on top of mountains or in streams be made into smaller rocks?
     ✔ Get at the idea that rocks can fall off mountains and rub against each other in streams. You may want to drop larger rocks on each other. Be careful to keep feet out of the way and protect eyes.

   - How could big rocks help pulverize sand in streams?
     ✔ Test out ideas.

   - Do you have any additions for the concept map about soil?

EXTENSION

- Visit a stream bed or rock slide and look at rocks, sand, and silt for clues to natural soil formation.

ILLUSTRATION

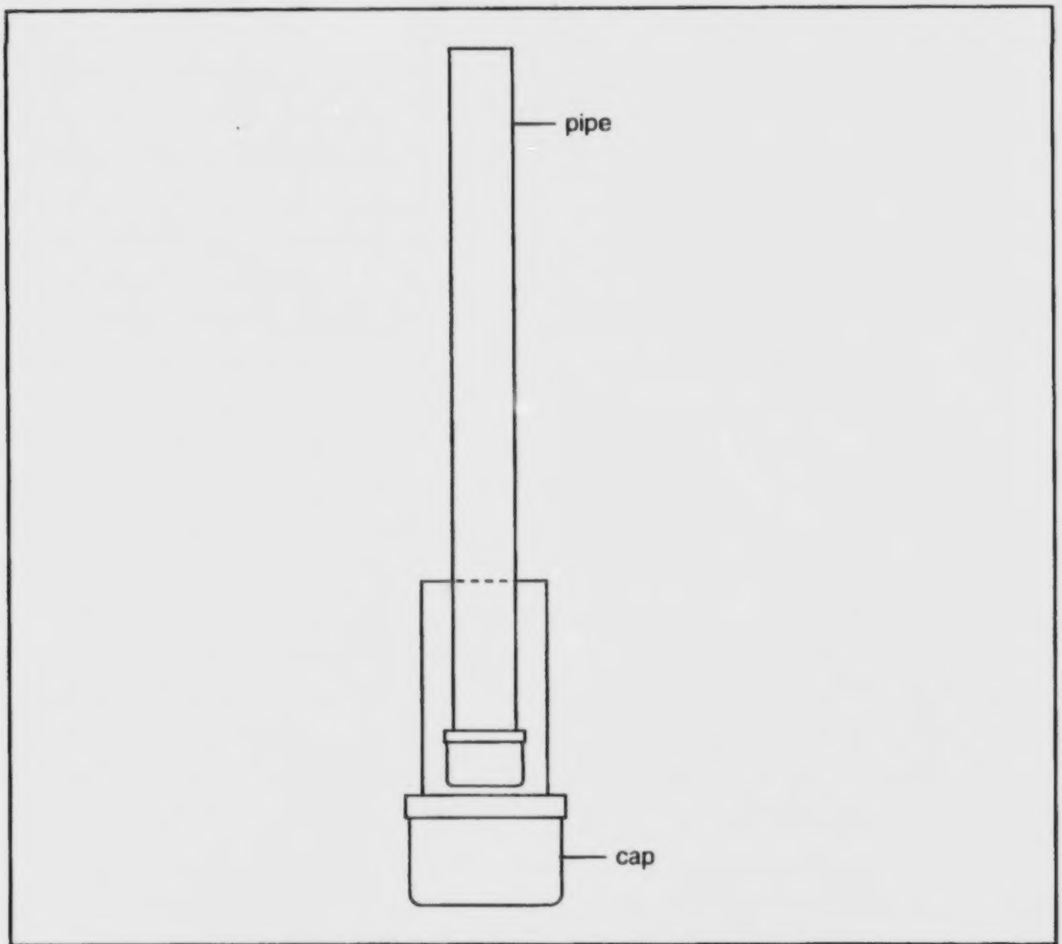

Figure 2.4.2 Stamp mill rock crusher.

DASH

MAKING SOIL
SP 2.4.2

Name: ____________________

Date: ____________________

SOIL RECIPE		
INGREDIENT	AMOUNT	UNIT

SOIL	MASS/WEIGHT Unit:	VOLUME Unit:
Biggest Pieces		
Medium Big		
Medium Smalll		
Smallest Pieces		

2.4.3 SOIL AND PLANTS

OBJECTIVES

The students
- Experiment to see in which soil plants grow best, natural or student made.
- Make hypotheses about what constitutes good soil.

BACKGROUND

This activity follows Activity 2.4.2 MAKING SOIL. In SOIL AND PLANTS the students determine the relative capacity of natural and student-made soils to support the growth of plants.

Suggested Plants

Radishes and bird seed are suggested for testing because they are quick-growing plants.

Growing Conditions

From DASH K and 1 the students will have a fair idea that plants need soil, water, and sunlight or a grow-light to grow. They should use this knowledge to set up the growing conditions for testing their soils. Use window space if possible.

Expected Results

Soil containing oil or other chemicals may prevent the germination of seeds. Soils that are low in soluble nutrients will produce sickly plants. Freshly crushed rock normally will not have much soluble nutrient material. Radishes and bird seed should grow to some degree in both the natural and student-made soil. However, they will usually grow much better in good natural organic soils.

STUDENT ROLE

Agronomist

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MATERIALS

concept map about soil from Activity 2.4.1 SOIL
soil samples from Activities 2.4.1 SOIL and 2.4.2 MAKING SOIL
radish or bird seeds
half-pint milk cartons or recycled plastic or Styrofoam cups for growing chambers
nails to punch holes in the bottoms of chambers
aluminum pie pans or other drainage containers
water
Student Page 2.4.3 SOIL AND PLANTS

PRODUCTS

Team Responsibility Charts
Growing plants
Completed Student Pages

PROCEDURES

1. **Review the concept map about soil with the students and introduce the problem of growing plants in different kinds of soil.**

   Ask such questions as these:
   - What do you know about the relationship between soil and plants?
   - Do you think that plants will grow in all kinds of soil or only some kinds of soil?
     ✔ Have them record their predictions.
   - Will plants grow in the soil you made?
     ✔ Have the students record their predictions.

2. **Have the students invent a way to test their predictions. Remind the students that they have samples of soil from Activities 2.4.1 SOIL and 2.4.2 MAKING SOIL.**

   Help them by
   - Putting half-pint milk cartons, recycled plastic or Styrofoam cups, pie pans, seeds, and other materials in the Inventor's Box.

- Asking how they are going to provide water over weekends. ✔ Help them recall using water in pans under growing containers that have holes in the bottom.

- Asking how they are going to provide light.

- Asking how and when they are going to observe their plants. ✔ Work toward a schedule for daily observation.

3. **Have the students run the experiments for 20 days or so while making and recording observations daily.**

Help them

- Make a team Responsibility Chart.

- Draw or describe their experiment.

- Record their observations on Student Page 2.4.3 SOIL AND PLANTS. Use one page for each sample.

4. **Have the students share and compare their experimental results.**

Ask such questions as these:

- Did plants grow in all the kinds of soil that you tested?

- Were your predictions correct? How?

- Are there kinds of soil that plants might not grow in?

- Were there some kinds of soil that plants grew better in than others?

- Which soils seem to have been the best for growing plants?

- Why do you think these were the better?

- Which soils seem to have been the worst for growing plants?

- What kind of soil would you want to use in future growing activities?

EXTENSION

- Have the students grow other kinds of plants in the soils they have made.

DASH

SOIL AND PLANTS SP 2.4.3

Name: ______________________

Date: ______________________

Kind of plant:

Kind of soil:

Date planted:

DATE	HEIGHT(cm)	OBSERVATIONS

2.4.4 SOIL USES

OBJECTIVES

The students
- Develop a working definition of natural soil.
- Explore the uses of soil.

BACKGROUND

This activity is designed to encourage students to observe how soil is used at home, at school, and in the community. SOIL USES is a companion to Activity 2.4.5 FINDING SOIL, and it should follow Activity 2.4.3 SOIL AND PLANTS.

Uses

The students will find that soil is used in many places including gardens, farms, potted plants, fill for house foundations, road work, levees, habitats for small animals, and even as a filter for ground water.

Soil Definition

Natural soil refers to the loose topmost layer of the earth's surface that contains crushed rock materials, organic matter, and supports flourishing plant growth. *Supports flourishing plant growth* means that a wide variety of plants grow and reproduce in it.

Soil is distinguished from sand, gravel, and rocks that are other components of earth's topmost layer in which most plants do not flourish. Another category of material in the top layer in which plants do not flourish is rubble, which is mostly broken building material from human activities.

Approach

The students develop a working definition of soil from their work in Activities 2.4.1 SOIL and 2.4.2 MAKING SOIL. They then look for other ways that soil is used and record them on a class chart about the uses of soil or on their concept map about soils .

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STUDENT ROLE

Agronomist

MATERIALS

chart paper
Working Dictionary
concept map about soil
Student Page 2.4.4 SOIL USES

PRODUCTS

Working definition of soil
Class chart about the uses of soil
Completed Student Pages

PROCEDURES

1. **Review the concept map about soil and the work done to date with soil. Help the class develop a working definition of natural soil.**

   Ask such questions as these:
   - What did you find in your analysis of the soil that you brought in from the field?
     ✔ List the things found in Activity 2.4.1 SOIL, including fine clay, sand, gravel, and plant and animal matter.

   - What did you put in the soil you made?
     ✔ List the things from the recipes in Activity 2.4.2 MAKING SOIL.

   - What were some differences you could see between the natural soils and the soils you made?
     ✔ Get at the idea that the soils that they made were not as fine grained as the natural soil.
     ✔ Usually plants will have grown better in natural soils.

   - What is your working definition of a natural soil?
     ✔ Record the definition in the Working Dictionary.

2. Introduce the next investigation, *Now that you know what soil is, what are the ways it is used?* Help the students add to their concept map about soils or set up a separate class chart about the uses of soil.

Have the students

- List things that soil is used for.
  ✔ Have the students work in small groups to list the things that soil is used for and where they have seen it used this way.

- Organize a class chart about uses of soil using these group inputs or add these to the exiting concept map about soils.

- Find additional uses for soil different from those already listed.
  ✔ To get as an extensive listing as possible, have each student find at least 2 uses not already on the chart or concept map as a home assignment. Use Student Page 2.4.4 SOIL USES.

- Report on the uses and add them to the chart or concept map.
  ✔ Keep the chart or concept map up for awhile and have the students add to it whenever they see a new use for soil.

EXTENSION

- Have the students write a story about soil's contribution to their lives.

DASH

SOIL USES
SP 2.4.4

Name: ____________________

Date: ____________________

USE								
WHERE								
DATE								

2.4.5 FINDING SOIL

OBJECTIVES

The students
- Refine their working definition of natural soil.
- Determine what kinds of things on the earth's surface can be considered to be natural soils.

BACKGROUND

In this activity the students find things that can and cannot meet their definition of soil. FINDING SOIL is a companion to Activity 2.4.4 SOIL USES and follows after it.

Approach

The students are asked to find things that are part of the earth's surface that do or do not meet their definition of a natural soil. In Activity 2.4.4 SOIL USES they developed a working definition of natural soil. This definition usually includes the capacity of natural soils to support abundant and varied plant growth. In FINDING SOIL the students use their definition and are asked to find other components of the earth's topmost layer that support and don't support good plant growth. The students invent their own tests of the capability of these components to support plant growth. The procedures used in Activity 2.4.3 SOIL AND PLANTS can again be used.

Non-soil Components

Things in the topmost earth layer that don't support good plant growth and are not considered to be soil include sand-covered areas, rocks, gravel bars, chemical-covered ground, concrete and asphalt-covered ground, and others. These may support some limited growth but not flourishing growth of a wide variety of plants.

STUDENT ROLE

Agronomist

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MATERIALS

magnifying glasses
sieves from Activity 2.4.1 SOIL
growing chambers
bird seed
radishes
chart paper
Working Dictionary
Connections Book
Student Page 2.4.5 SOIL SAMPLE REPORT

PRODUCTS

Completed Student Pages

PROCEDURES

1. **Review the working definition of natural soil recorded in the Working Dictionary. Where needed expand the definition to include soil's support good growth in different plants.**

   Ask such questions as these:
   - What is natural soil composed of?
   - How is the support of life used to identify the presence of natural soil?

2. **Introduce the investigation problem, *What kinds of things are found to be soils or like soils?***

   Ask such questions as these:
   - Is the dirt in a vacuum sweeper soil? Can plants grow well in it if they are watered?
   - Is stream sand soil? Can plants grow well in it if they are watered?
   - Can plants grow well in broken pieces of asphalt if they are watered?
   - Can plants grow well in broken concrete if they are watered?
   - Can plants grow well in clay if they are watered?

- What are some other things that are part of the earth's surface that you can test to see if plants will grow in them?

3. **Have the students invent tests for materials found in or on the earth to answer the question, *What kinds of things are found to be soils or like soils?***

   Have the students
   - Carry out their investigations.
   - Describe their results on Student Page 2.4.5 SOIL SAMPLE REPORT.
   - Report to the class as they get answers to their research.
     ✔ Have them post their reports for others to see.

4. **Summarize the study of soil with the students. Record their ideas in the Connections Book.**

   Ask such questions as:
   - Why is it important to know about soil?
   - Who needs to know about soil?
   - Where might you use what you know about soil?

EXTENSION

- Have the students make a bulletin board display with the samples of the soil or soil-like earth they have tested.

DASH

SOIL SAMPLE REPORT
SP 2.4.5

Name: ____________________

Date: ____________________

Describe your sample.

When and from where did you collect it?

Describe your soil test.

DATE	OBSERVATIONS

Describe your results.

3.4.13 FLOWERS

OBJECTIVES

The students
- dissect flowers
- identify the flower parts
- make a herbarium sheet showing the parts of the flower

BACKGROUND

This is the first of three activities dealing with plant reproduction. It is usually done before plants begin to grow in the class garden. The students dissect several kinds of flowers and identify their parts.

Some flowers may be found on the school grounds. Be sure the students get permission from the grounds maintenance staff before picking any campus flowers. Flowers can also be brought from home gardens. An ample supply can often be obtained from the discards of florist shops or funeral homes.

Large blooms from lilies or hibiscus plants have easily identifiable parts. See Figures 3.4.13(1) and 3.4.13(2). Most flowers can be dissected with a fingernail or a straight pin. Have a single-edged razor blade or an Exacto knife on hand to help students who find the ovaries difficult to open.

This is an opportune time to introduce the students to the scientific terms for the parts of a flower. As in the case of animal terminology, these words are useful in talking about particular plant processes. See Figures 3.4.13(1) and 3.4.13(2).

The primary function of a flower is to reproduce the plant. Each part of the flower has a particular role in this process. The green *sepals* found under the petals protect the flower during the bud stage. The *petals* surround the reproductive parts of a flower. The petals protect these parts and attract insects.

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The essential parts of a flower are the *pistil* (female parts) and *stamens* (male parts). A flower usually has several stamens. Each stamen has a thin stalk or *filament*. At the top of the stamen is an *anther*, which holds a yellow or reddish powder made up of *pollen* grains. The pistil is located in the center of a flower. The sticky knob on top, called the *stigma*, catches the pollen. The stigma is supported by the *style*, which connects it to the *ovary*. The *ovary* is the fat part at the bottom of the pistil. Inside the ovary are *ovules* containing eggs that grow into seeds after they have been fertilized by sperm in the pollen grains.

STUDENT ROLE

Botanist

MATERIALS

flowers
hand lenses
straight pins
Exacto knife or single-edged razor blade
manila or botany paper
newspaper
flat board the same size as the manila paper
cement block, books, or a large rock for weight
white glue
plastic wrap
Wonder and Discover Book
Student Page 3.4.13 FLOWERS

PRODUCTS

Flower herbarium sheets
Completed Student Pages

PROCEDURES

1. **Review the major parts of plants and discuss the possible function of flowers with the class.**

Ask such questions as these:

- What are the parts of plants? (Roots, stems, leaves, flowers, and fruit.)
- Do all plants have all of these parts? Do grasses? (No stems.) Mosses? (No stems.) Mushrooms? (No leaves.)
- Do most plants have flowers? Can you think of exceptions? (This is an opportunity to use the Wonder and Discover Book.)
- What do you think is the function is of flowers? What makes you think this? (Accept all hypotheses.)

2. **Introduce the activity of looking closely at flowers and dissecting them to see their smaller parts.**

Discuss and plan the following with the students:

- How to get a variety of kinds of flowers.
- How to get at least four samples of each kind of flower.

3. **Have the students observe their flowers and identify the parts.**

Have them do the following things:

- Cover their working area with paper.
- Observe the whole flower with and without a hand lens.
- Draw the undissected flower and identify the parts with numbers on Student Page 3.4.13 FLOWERS.
- Share their flowers and diagrams with nearby students so that the similarities and differences can be identified.
- Give names to the common structures. (See Figure 3.4.13[1].)

4. **Have the students dissect their flowers.**

Help them carry out the following operations:

- Open the pollen case or *anther* of a *stamen.* (See Figure 3.4.13[1].)
- Observe with a hand lens.
- Draw the stamen on their diagram.
- Share their diagrams so that the similarities and differences can be identified.
- Give names to the common structures. (See Figure 3.4.13[2].)
- Shake the *pollen* from one flower into the center of another and observe where the pollen sticks. (If the students are successful, they will see the pollen stick on the *stigma* at the tip of the *style*. The *style* is the relatively long column leading down to the ovary. The whole structure is called the *pistil.*)

- Locate the *ovary* at the base of the pistil.
- Open the ovary.
- Locate the sack-like structures called the *ovules*.
- Observe these with a hand lens.
- Count the number of ovules.
- Draw the pistil and ovules.
- Share their diagrams with other students so the similarities and differences can be identified.
- Give names to the common structures. (See Figure 3.4.13[2].)

5. **Discuss observing what happens naturally to the parts of flowers in the garden plants. See Activity 3.4.14 SEEDS.**

6. **Have the students make a herbarium sheet of their flower to show the parts.**

   Help them do the following:
   - Open and cut the flower so that the ovary and other parts are exposed for pressing.
   - Label a piece of absorbent manila or botany paper with the name of the plant, the date, and the student's name.
   - Place the flower with the parts visible on the paper.
   - Cover the flower with several layers of newspaper.
   - Stack the herbarium sheets and newspaper.
   - Place a board on top of the stack.
   - Place a cement block or other heavy weight on top of the board.
   - Allow to dry for several weeks.
   - Carefully separate the herbarium sheets with the pressed flowers.
   - Attach the flower to the paper with a tiny amount of glue if necessary.
   - Label the parts.
   - Cover the herbarium sheets with plastic wrap or laminate.

EXTENSION

- Have the students assemble a class book of their pressed dissected flowers.

ILLUSTRATIONS

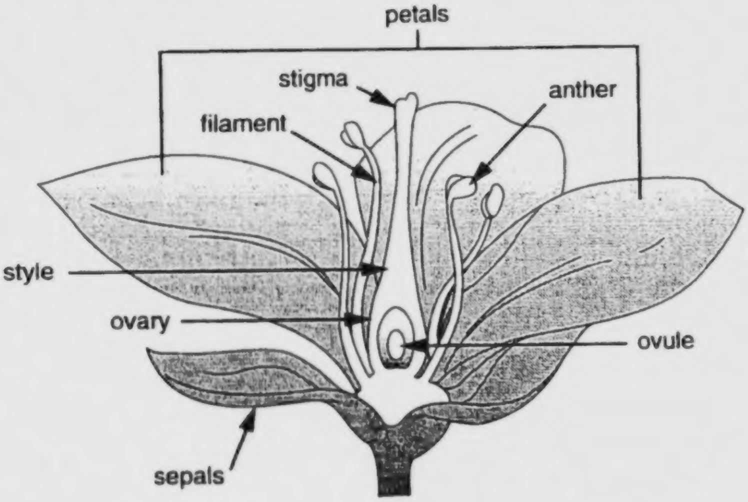
petals
stigma
anther
filament
style
ovary
ovule
sepals

Figure 3.4.13(1) Parts of a flower

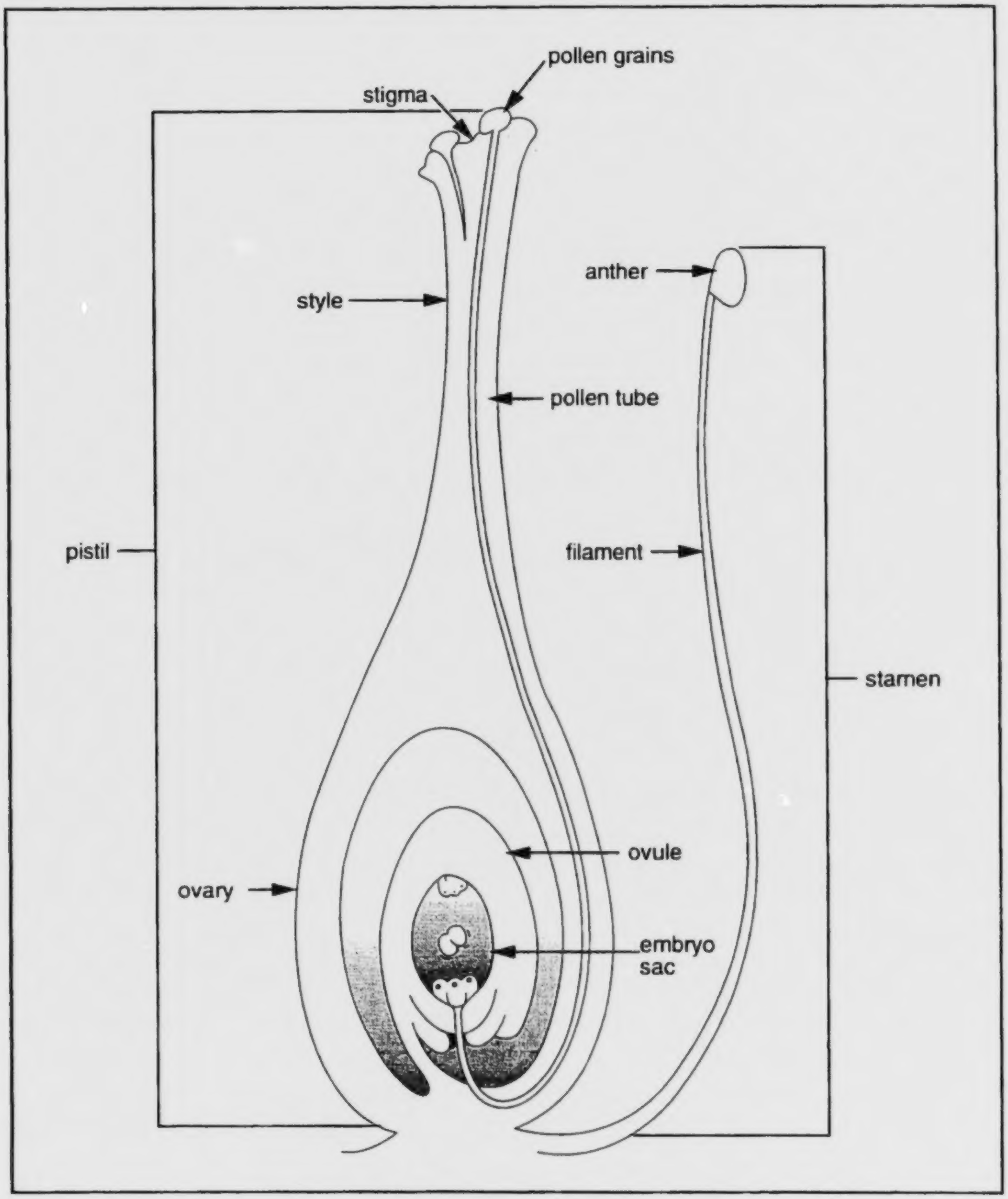
pollen grains
stigma
anther
style
pollen tube
pistil
filament
stamen
ovule
ovary
embryo sac

Figure 3.4.13(2) Flower stamen and pistil

DASH

FLOWERS
SP 3.4.13

Name: ____________________

Date: ____________________

Draw and label the parts of the flower you dissected.

3.3.7 FROG METAMORPHOSIS

OBJECTIVES

The students
- Collect frog and/or toad eggs.
- Observe and record the development of the eggs into tadpoles.
- Observe and record the metamorphosis of tadpoles into adult frogs or toads.
- Release the frogs and/or toads into their natural environment.

BACKGROUND

This activity follows Activity 3.3.6 MAKING HABITATS FOR FROGS AND TOADS. Student teams of two to four students collect frog and/or toad eggs and place them in the habitat that they constructed. They observe and record the development of the eggs, the metamorphosis of tadpoles, and the release of the adults into their natural environment.

In most parts of the United States, frogs and toads deposit their eggs in spring. Frogs and toads are quite vocal in the evening during their reproductive cycle. Eggs are found close to the surface of the water near the shore and are usually attached to grass or reeds. Toad egg masses are deposited in long strings while those of frogs are in shapeless globs. The number of eggs in a mass will vary with the species. Individual eggs are surrounded by a gelatinous, transparent sphere that swells in the water.

Have the students go on a field trip to a pond to collect eggs. If this is not possible, there are several alternatives. Have the students bring in eggs. If this is done, it is advisable to send a letter home asking for adult help with the collection. Older students who have done this collecting before may be called on to assist in this activity. Ask for help from your DASH training institution, contact a high school or university biology teacher, or the local Sierra Club. In some urban areas it may be necessary to purchase the eggs from a biological supply house.

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The eggs can be brought to school in a jar with air holes in the lid. The jar should be kept at 60°–80° F or 15°–25° C. On a field trip keep the jar in the shade in a bucket of pond water.

Individual eggs can be separated from the larger mass and observed in a jar lid. Leave the white seal in the lid to provide a good background. The eggs should be covered with water at all times. Have the students use a hand lens to make observations.

After observation single eggs can be kept in small bottles with holes in the lid to allow water to pass in and out. A small piece of water plant should be added to the bottle. Label the bottles for retrieval and keep them on the bottom of the habitat. See Figure 3.3.7(1).

Depending on the frog or toad species and water conditions, the developing tadpole will remain in the gelatinous covering for 8–20 days. The tadpoles may emerge sooner than eight days since it will not be known when the egg mass was laid. In the early stage, the gelatin-covered eggs will be spherical with a light-colored bottom side and dark-colored top. In a few days, the shape will become more like a tadpole.

Tadpoles wiggle out of their gelatinous covering and attach themselves to the remaining egg mass or to plants. Within several days the tadpoles become free swimming and begin to feed on pond scum. All tadpoles should be allowed to swim freely. For closer observation single tadpoles can be put in large jars that have the same habitat features of the larger class habitat. Tadpoles are herbivorous and live on algae. Adequate algae can be maintained by periodically exchanging the water in the jars with water from the class habitat. Tadpoles can be captured with a small net and observed in a jar lid in the same way the eggs were observed. Metamorphosis of the tadpole through the adult stage takes two to three months for most species of toads and frogs. However, bullfrogs take up to two years to go through the tadpole stages.

The length of a tadpole can be measured by placing grid paper under a clear petri dish or any clear plastic container and observing the length against this background. See Figure 3.3.7(2). The volume of a tadpole can be measured by displacement. Have the students make a small graduated container with vertical sides. See Activity 3.10.12 MEASURING DEVICES. Fill the container half full, add the tadpole, and determine how much the volume of water and tadpole increases. The difference between the two volumes is the volume of the tadpole. See Figure 3.3.7(3). The mass of a tadpole can be measured on student-made balances. First measure the mass of the water alone. Then measure the mass of the tadpole and the water. The difference between the two masses is the mass of the tadpole. See Activity 3.10.12 MEASURING DEVICES.

It is suggested that the frogs and tadpoles be released into their natural environment soon after they reach the final adult stage of metamorphosis. Toads can be released into the garden where they help with insect control. See Activity 3.3.9 TOADS AND INSECTS.

STUDENT ROLES

Zoologist
Inventor

MATERIALS

graduated container (See Activity 3.10.12 MEASURING DEVICES)
balance (See Activity 3.10.12 MEASURING DEVICES)
class habitat from Activity 3.3.6 MAKING HABITATS FOR FROGS AND TOADS
hammer
nails
string
index cards
waterproof pen
jars
jar lids
small bottles
wire and open-weave cloth or recycled stockings for nets
grid paper
shallow clear plastic containers or glass containers
hand lenses
frog and/or toad eggs
Student Page 3.3.7 FROGS AND TOADS

PRODUCTS

Nets
Observation systems
Microhabitats
Completed Student Pages

PROCEDURES

1. **Have the students plan and prepare to observe the development and metamorphosis of frogs and toads.**

   Help them include such things as
   - How to obtain the eggs.
     ✔ This decision will require consultation with the teacher. Organization may be extensive if eggs are to be collected on a field trip.

   - How the eggs are to be transported to the school.

   - Responsibility Charts and observation schedules.
     ✔ The first few observations should be done by all students.

   - Invention and construction of microhabitats and observation systems.

2. **Have student teams put the eggs into the class habitat and their microhabitats and begin making observations. See Figure 3.3.7(1). Have them use Student Page 3.3.7 FROGS AND TOADS to record their observations.**

   After the first observation ask such questions as
   - How large is the jelly capsule?

   - How did you measure it?

   - Has the capsule changed in size? If so, how?

   - How big is the egg?

   - How did you measure it?

   - Has the egg changed in size?

   - What does the egg look like?

   - How has the egg changed?

   - How does the tadpole get out of the gelatinous covering?

   - Where do the tadpoles go when they get out of the gelatinous covering?

3. **When the tadpoles are free swimming, have the students transfer them to larger jars and invent and make small nets to capture the tadpoles for further observation.**

4. **Have the students invent a way to determine the length, volume, and mass of a tadpole.**

5. **Have student teams carry out their observations and measurement plans for the developing tadpoles.**

6. **When the tadpoles reach the adult stage, have the students make plans for further observations that can be done in the class habitat or in the natural environment.**

7. **Have the student teams give their reports. Then have the class summarize their observations of the tadpoles.**

   Ask such questions as these:
   - What are the things that happened in the development and metamorphosis of all the frogs and toads?
   - What things were different in our observations of frogs and toads?
   - Why did the teams try to make measurements and close observations of the same egg or tadpole each time?
   - How are frogs and toads similar to insects in their development?
   - How are frogs and toads different from insects in their development?

EXTENSION

- Have the students make class books on the metamorphoses of different species of frogs and toads.

ILLUSTRATIONS

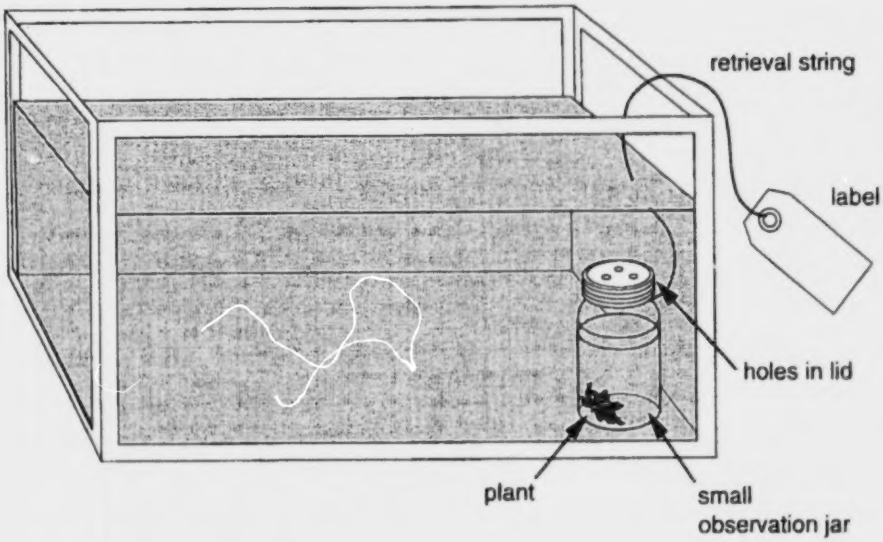
retrieval string
label
holes in lid
plant
small observation jar

Figure 3.3.7(1) Microhabitat

1096

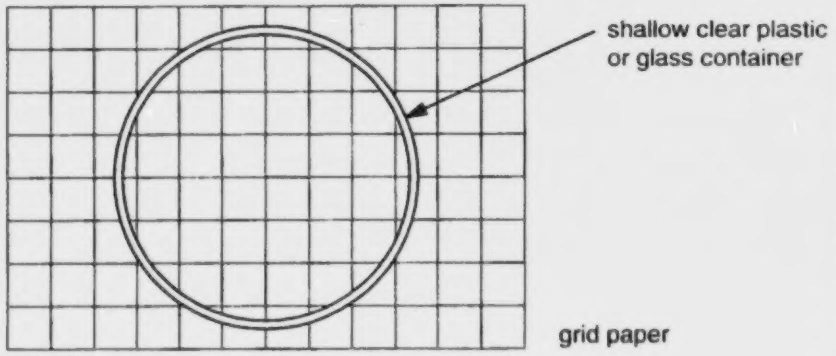
shallow clear plastic or glass container
grid paper

Figure 3.3.7(2) Observation System

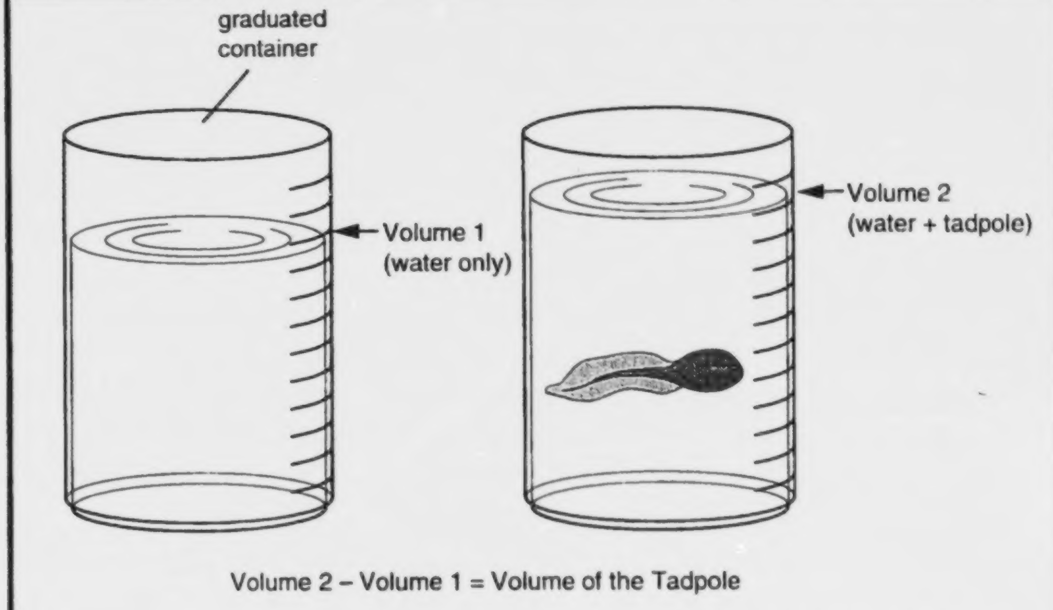
graduated container
Volume 1 (water only)
Volume 2 (water + tadpole)
Volume 2 – Volume 1 = Volume of the Tadpole

Figure 3.3.7(3) Finding the Volume of a Tadpole

DASH

FROGS AND TOADS
SP 3.3.7

Name: ____________________

Date: ____________________

Date	length (cm)	volume (mL)	mass (g)	Observations

3.5.1 FOOD SELECTION

OBJECTIVES

The students

- Review the Activation, Regulation, and Fabrication (ARF) System of classifying foods according to the way the body uses them.
- Determine how many servings of each of the three food groups they need to serve their family for one day.
- Make a shopping list based on a budget.
- Purchase needed items at the class supermarket.
- Calculate the amount of food left over from one day's meals.

BACKGROUND

This activity is used with three activity sequences—the Class Supermarket, the Class Garden, and the Class Feast. If the gardening and feast activities are done before the supermarket activities, complete this activity through Procedure 2. Then proceed to Activity 3.5.2 SELECTING PLANTS FOR THE GARDEN. If the supermarket sequence comes first, complete this entire activity after Activity 3.5.12.

The students begin with a review of the ARF system for classifying foods. In this system foods are classified by the way the body uses them—for **activation**, **regulation**, and **fabrication**.

After the review of the ARF system, the size of servings and the number of servings needed by a person each day are introduced. This information gives the students a tool for selecting the food to be purchased by the Consumer Group during the Supermarket Game. Student Page 3.5.1A FOOD SELECTION gives them information on how much food constitutes a serving. Other information is provided through music, rhymes, aphorisms, and charts. An additional list of foods and their serving sizes can be found in the World Almanac under the heading "Nutritive Values." Serving size is found in the "measure" column.

Serving size information is used in three ways. The students plan menus for their at-home families, for their team families when they

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are the Consumers during the Supermarket Game, and for their Class Feast.

As a first activity, the students are given a food budget for planning their at-home family's meals for one day. A realistic amount based on what is generally spent per person per day for food by families in the class should be used. Generally this will range from $3.00 to $10.00 per person multiplied by the number of people in each student's family.

In the Supermarket Game the Consumer Group is given a similar budget for its team families. The students make a menu plan for a day and a shopping list from the foods available in the Class Supermarket. When the Supermarket Group publishes its special food ads, encourage the students to use the ads to get the best value for their money.

Do not be concerned with the varying amounts of foods in serving sizes shown on Student Page 3.5.1A FOOD SELECTION. Arriving at precise serving sizes is too complex for grade 3 students. Determining serving size involves knowing the density of foods and their nutritional content, two concepts not yet developed. For these activities simply present the information as shown. For further information on foods not found on the student pages, see Figure 3.5.1(7) Suggested Serving Sizes.

STUDENT ROLES

Consumer
Householder

MATERIALS

assorted food containers
measuring cups
measuring spoons
balances (See Activity 3.10.12 MEASURING DEVICES.)
baby-food jars
volume jars (See Activity 3.10.12 MEASURING DEVICES.)
class supermarket
special ads for the class supermarket
Student Pages 3.5.1A FOOD SELECTION
3.5.1B FOOD SERVINGS
3.5.1C SHOPPING LIST
3.5.1D LEFTOVERS

PRODUCT

Completed Student Pages

PROCEDURES

1. **Review the ARF System for grouping foods with the class using the ARF FOOD GROUP RHYME, the ARF NUTRITION WHEEL, and the ARF FOOD GROUP SONG. See Figures 3.5.1(1–3).**

2. **Have the students use the ARF NUTRITION WHEEL (Figure 3.5.1(3)) to identify the ARF food groups on pages 1–4 of Student Page 3.5.1A FOOD SELECTION.**

   Have the students
   - Use the ARF Nutrition Wheel to identify the ARF groups listed on Student Page 3.5.1A FOOD SELECTION.

   - Compare their lists and agree on which foods belong to multiple ARF groups.

3. **Introduce the idea of serving size to the students by discussing the information on Student Page 3.5.1A FOOD SELECTION.**

   Have the students
   - Fill food cans of various sizes with water to measure and compare their volume.
     ✔ See Activity 3.10.12 MEASURING DEVICES.

   - Find the serving sizes given on canned, frozen, and other packaged foods.

   - Note that a serving of meat is usually 3 oz or 85 g.

   - Discuss the need for a wide variety of foods to get all the nutrients the body needs.

4. **Have the students discuss the number of servings of each ARF food group that should be eaten each day. Use the ARF APHORISM (Figure 3.5.1(4)) and the top of Student Page 3.5.1B FOOD SERVINGS to introduce this information.**

   Ask such questions as these:

- Why do you think that the number of servings of **fabrication** foods suggested varies from 4 to 6 while the number of servings suggested for **activation** and **regulation** does not?
  ✔ Get at the idea that some people may need more food than others to build and repair their bodies.

- When do people need more food?
  ✔ Get at the idea that when they are growing or doing hard work, people have to rebuild their bodies.

- How many servings of food do you think we need at each meal?
  ✔ Get at the fact that many of us eat more at dinner and lunch than at breakfast.

- How many servings of each food group do we get in our school lunch?
  ✔ School lunch usually provides at least 1/3 of the daily recommended nutrition requirements for a child.

5. **Have the students make menus for their own (at-home) families.**

Have the students discuss
- Making a menu on Student Page 3.5.1B of the food needed for breakfast, lunch, and dinner.

- Using the ARF Food Groups to be sure they have planned nutritious meals.

- Using the needs of their own at-home families.

- Considering the food likes and dislikes of their family members.

6. **Before the Supermarket Game, discuss the need to make a menu and a shopping list in order to purchase food wisely from the Class Supermarket.**

Have the students discuss
- Making a menu on Student Page 3.5.1B of the food needed for breakfast, lunch, and dinner.

- Using the ARF Food Groups to be sure they have planned nutritious meals.

- Considering the needs of their team families.

- Considering the food likes and dislikes of their team's family members.
- Getting as economical a selection of foods as they can by using the food ads for the Class Supermarket.
  ✔ See Activity 3.5.11 FOOD ADS AND BANKING.

7. **Before or during the Supermarket Game, have the students make a menu for one day's meals for their team family.**

   Have them
   - Use Student Page 3.5.1B FOOD SERVINGS to plan for a day.
   - Determine how many servings of food are needed for their team family each day.
   - Decide what food to buy.
   - Decide how many servings of each food to buy.

8. **During each round of the Supermarket Game, have the Consumer Group calculate how much food it needs and its cost on Student Page 3.5.1C SHOPPING LIST using its assigned food budget, the Supermarket Price List, and Sale Ads.**

   Have them
   - Find the cost of each item on the list.
   - Calculate the total cost of the list.
   - Revise the list to stay within the budget.

9. **Have the Consumer Group go to the Class Supermarket and make its purchases. If a food listed is unavailable, have the group make a substitution, taking into consideration the food group and the cost.**

10. **Have the students match the number of servings of each ARF food group in the containers they have purchased with the number of servings their family needs. Use Student Page 3.5.1D LEFTOVERS to calculate the amount of leftover food.**

11. **After all the rounds of the game have been played, summarize the activity with the class.**

Ask such questions as these:

- Did the Supermarket have all of the things you wanted to buy?
- What kinds of substitutes did you have to make?
- How did this change your menu?
- Did the substitute foods cost more or less?
- What could you plan to do with your leftover foods?
- What would you do differently the next time you need to buy food?

EXTENSION

- Have the students take extra copies of the Student Pages home to plan menus and shopping lists with their families.

ILLUSTRATIONS

THE ARF FOOD GROUP RHYME

Grains and butter, a sesame seed roll,
Potato and sugar, cereal in a bowl.

These are foods for **activation**.

For crawling and climbing, getting all hot,
For running and jumping, turning on a dot.

Making bodies move is **activation**.

Spinach and cauliflower, corn on the cob,
Apples and oranges, pureed peaches in a glob.

These are foods for **regulation**.

For digesting and defending, controlling things inside,
For seeing and thinking, directing what's supplied.

Making bodies work is **regulation**.

Steak and beans, roasted chicken legs,
Milk and codfish, ham served with eggs.

These are foods of **fabrication**.

For building and maintaining, making muscles strong,
For repairing and growing, making bone that's long.

Making bodies grow is **fabrication**.

Figure 3.5.1(1) The ARF Food Group Rhyme

THE ARF FOOD GROUP SONG

Activation, activation,
Makes me move, groove and move.
Potatoes, rice, and shredded wheat,
Butter, bread, and candy sweet,
Activation foods,
Activation foods.

Regulation, regulation,
Makes me work, perk and work.
Spinach, corn, and cauliflower,
Apples, raisins, fiber power.
Regulation foods,
Regulation foods.

Fabrication, fabrication,
Makes me grow, repair and grow.
Beans, chops, and turkey legs,
Milk, fish, steak, and eggs,
Fabrication foods,
Fabrication foods.

(Sing to the tune of "Are You Sleeping?")

Figure 3.5.1(2) The ARF Food Group Song

1107

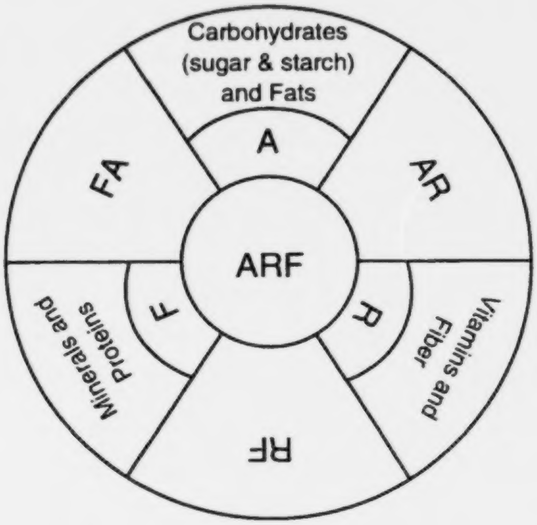
Carbohydrates
(sugar & starch)
and Fats
A
AR
R
Vitamins and
Fiber
RF
F
Proteins
Minerals and
FA
ARF

Figure 3.5.1(3) The ARF Nutrition Wheel

ARF APHORISM

Eat the group of three
In wide variety.
When selecting foods in the right amounts,
Remember the ARF serving counts.
We need 4 servings of A and 4 of R,
And 4–6 of F to be up to par.

Figure 3.5.1(4) ARF Aphorism

MEASUREMENT EQUIVALENTS

1 teaspoon	1/3	tablespoon		1/6	fl oz*		.005	liter
	5	grams						
1 tablespoon	3	teaspoons	1/2	fl oz	.015	liter	14	grams
4 tablespoons	1/4	cup	1/8	lb (2 fl oz)	.06	liter	57	grams
1 cup	1/2	pint	1/2	lb (8 fl oz)	.24	liter	228	grams
2 cups	1	pint	1	lb	.47	liter	454	grams
2 pints	1	quart**	2	lb	.94	liter	908	grams

* Food usually weighs about the same as an equal volume of water. One (1) pint of water weighs about 1 pound. One (1) pint of processed food such as vegetables and fruits packed in cans or frozen packaged foods, weighs about 1 pound.

** For estimating volumes, 1 quart is about equal to a liter.

Figure 3.5.1(5) Measurement Equivalents

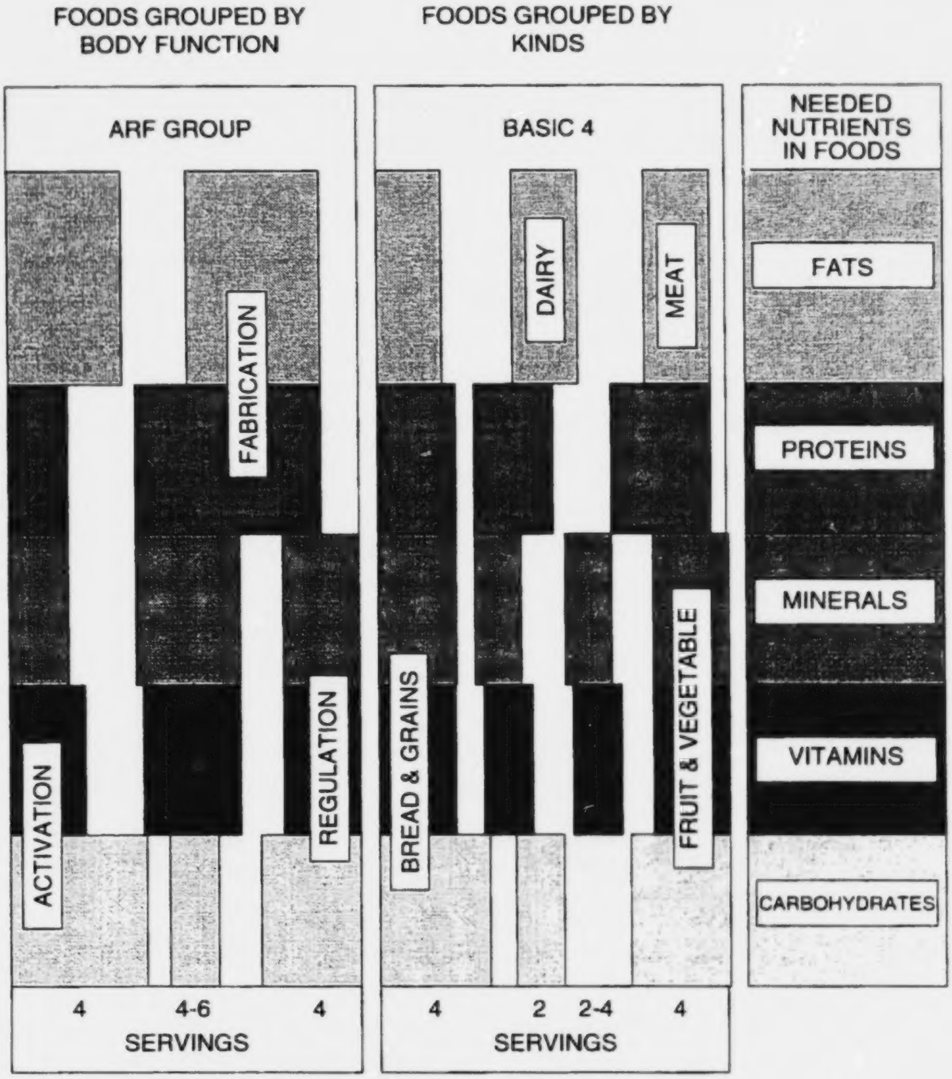
FOODS GROUPED BY BODY FUNCTION
FOODS GROUPED BY KINDS
ARF GROUP
BASIC 4
NEEDED NUTRIENTS IN FOODS
FABRICATION
ACTIVATION
REGULATION
DAIRY
MEAT
BREAD & GRAINS
FRUIT & VEGETABLE
FATS
PROTEINS
MINERALS
VITAMINS
CARBOHYDRATES
4
4-6
4
SERVINGS
4
2
2-4
4
SERVINGS

Figure 3.5.1 (6) Food Groups and Nutrients

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ONE SERVING					
	CUPS	OUNCES	PIECE	LITERS	GRAMS
CANNED VEGETABLES	1/2			1/8	
FRESH VEGETABLES	1/2			1/8	
CANNED FRUIT	1/2			1/8	
FRESH FRUIT			1		
MEAT		3			85
CHICKEN		3			85
FISH		3			85
DRINKS	1			1/4	
PASTRIES			1		
BREADS			1		
PASTA	1			1/4	

Figure 3.5.1(7) Suggested Serving Sizes

DASH

FOOD SELECTION
SP 3.5.1A
Page 1

Name: ______________________

Date: ______________________

FOOD	SERVING SIZE	ARF GROUP
APPLE	one	
BABY FOOD	1 jar	
BABY FORMULA	8 oz.	
BACON	2 slices	
BANANA	one	
BEANS, CANNED WITH PORK	1 cup	
BEANS, GREEN	1/2 cup	
GROUND BEEF OR STEAK	3 oz.	
BEEF STEW, CANNED	1 cup	
BOLOGNA OR OTHER LUNCH MEAT	1 (1 oz.) slice	
BREAD	1 slice	
BROCCOLI	1/2 cup	
BUTTER	1 tablespoon	
CABBAGE	1/2 cup	
CARROTS	1/2 cup	

DASH

FOOD SELECTION
SP 3.5.1A
Page 2

Name: ____________________

Date: ____________________

FOOD	SERVING SIZE	ARF GROUP
CATSUP	1 tablespoon	
CAULIFLOWER	1/2 cup	
CELERY	1 stalk	
CEREAL	1 cup	
CHEESE	1 (1 oz.) slice	
CHICKEN	2 pieces	
CHILI WITH BEANS, CANNED	1 cup	
EGG	one	
FISH	3 oz.	
FRUIT JUICE	1 cup	
GELATIN	1/2 cup	
GRAPES	10 large	
HAM	3 oz.	
HOT DOG	one	
ICE CREAM	1/2 cup	

DASH

FOOD SELECTION
SP 3.5.1A
Page 3

Name: ____________________

Date: ____________________

FOOD	SERVING SIZE	ARF GROUP
JELLY	1 tablespoon	
LETTUCE	1/2 cup	
MACARONI AND CHEESE	1 cup	
MARGARINE	1 tablespoon	
MILK	1 cup	
NOODLES	1 cup	
ORANGE	one	
PEACHES, CANNED	1/2 cup	
PEANUT BUTTER	2 tablespoons	
PEARS, CANNED	1/2 cup	
PEAS	1/2 cup	
PORK	3 oz.	
POTATO	1 large	
RAISINS	1-1/2 oz.	
RICE	1/2 cup	

DASH

FOOD SELECTION
SP 3.5.1A
Page 4

Name: ____________________

Date: ____________________

FOOD	SERVING SIZE	ARF GROUP
SALAD DRESSING	1 tablespoon	
SAUSAGE	3 links	
SHRIMP	5 pieces	
SPAGHETTI AND MEAT SAUCE, CANNED	1 cup	
SPINACH	1/2 cup	
SQUASH	1/2 cup	
SUGAR	1 tablespoon	
TOMATO	one	
TUNA, CANNED	1/2 cup	
YAM	1 small	

DASH

FOOD SERVINGS
SP 3.5.1B Page 1

Name: ______________________

Date: ______________________

How many people in your family?

ARF GROUP	BREAKFAST SERVINGS	LUNCH SERVINGS	DINNER SERVINGS	TOTAL NUMBER OF SERVINGS FOR ONE PERSON	TOTAL NUMBER OF SERVINGS FOR THE FAMILY
Activation				4	
Regulation				4	
Fabrication				4-6	

BREAKFAST MENU

FOOD	NUMBER OF SERVINGS NEEDED

DASH

FOOD SERVINGS
SP 3.5.1B Page 2

Name: ________________

Date: ________________

LUNCH MENU	
FOOD	NUMBER OF SERVINGS NEEDED

DINNER MENU	
FOOD	NUMBER OF SERVINGS NEEDED

DASH

SHOPPING LIST
SP 3.5.1C

Name: ______________________

Date: ______________________

FOOD	ARF GROUP	Breakfast, Lunch, or Dinner	Number of Servings	Number of Containers	Cost of Each Container	Total Cost
FOOD BUDGET $				TOTAL COST OF SHOPPING LIST		

SP 3.5.1D

DASH

LEFTOVERS
SP 3.5.1D

Name: ______________________

Date: ______________________

FOOD	SERVINGS BOUGHT	SERVINGS NEEDED	SERVINGS LEFT OVER

DASH 3.10.2 ACIDS AND BASES

OBJECTIVES

The students
- Make their own hydrion paper acid-base color scale.
- Make safety equipment to wear when handling acids and bases.
- Test the pH of various substances found in the classroom and at home.
- Compare and rank order the pH of the substances they test.

BACKGROUND

This is the second activity in the acid-base series. The students make hydrion acid-base color scales by matching colors to the standard that comes with the hydrion (pH) paper. They need to use a wide-spectrum crayon or colored pencil collection. Student groups compare their color selections to assure standard results when they use their acid-base scales to test the acidity and basicity (alkalinity) of different things in the classroom.

To test dry solids, put a small amount of the solid in water, stir, and then test the water. Chalk dust can be tested this way.

Small pieces of hydrion paper will usually give good color tests. The pieces should be .5 cm wide and sufficiently long so that the students don't touch the substances being tested. Alternatively, the pH paper can be held with a wooden clothespin or students may wear plastic gloves. The color change of the hydrion paper should be read within seconds of touching the substance since the color may fade over time. Hydrion or pH paper is not poisonous, but it should NOT be put in the mouth.

Safety is an important factor to consider whenever students are handling chemicals. Discuss safety procedures with the students. Be sure to include the need to wear **goggles** and plastic **aprons**. If students get an acid or base on their skin or clothes they should wash the area with plenty of water and tell the teacher. Although the chemicals used in this activity are not likely to burn either skin or clothing, good safety procedures should **always** be followed.

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Directions for making eye safety shields and aprons are in Activity 3.10.13 SAFETY EQUIPMENT. Standard safety goggles may also be used.

The materials suggested for use in these activities have pHs in the range of 1–12. Any substance with a pH above 12 is quite caustic and should be handled **only** by the teacher. It takes a considerable amount of water to flush away these strong bases. Skin and clothing will feel slippery as long as the base is present.

STUDENT ROLES

Chemist
Safety engineer

MATERIALS

chart paper
markers
crayons or colored pencils
wide-spectrum hydrion paper
goggles (See Activity 3.10.13 SAFETY EQUIPMENT)
aprons (See Activity 3.10.13 SAFETY EQUIPMENT)
wooden pinch-type clothespins
plastic gloves
small containers to hold samples for testing
eyedroppers
substances to test
Student Page 3.10.2 ACIDS AND BASES

PRODUCTS

Class chart of acids and bases
Completed Student Pages

PROCEDURES

1. **Have the students make a hydrion scale color chart.**

   Have them
   - Match the colors on the scale with their crayons or colored pencils.
     ✔ Get class agreement.

- Make their own color charts using Student Page 3.10.2 ACIDS AND BASES.
- Compare their charts within their own groups and between groups to be sure all charts are the same.

2. **Discuss with the class the need for safety when handling chemicals.**

   Include such things as
   - Wearing goggles or a safety shield to protect their eyes.
   - Wearing aprons to protect clothing.
   - Using wooden clothespins or plastic gloves to handle pH paper.
   - Washing the skin with lots of water if any chemical gets on it.
   - Washing clothing or other surfaces if any chemical is spilled on them.
   - Reporting to the teacher if a chemical is spilled on skin, clothing, tables, floor, or on anything.

3. **Have the students make any needed safety equipment. See Activity 3.10.13 SAFETY EQUIPMENT.**

4. **Give each student several small pieces of hydrion paper. Have the students test common substances found in the classroom and at home. Dry solids can be tested in a water solution. Caution them NOT to put their fingers in any caustic or toxic substances they might test. Have them wear goggles and aprons.**

   Have the students test such things as
   - Saliva
     ✔ Spit and test the liquid. DO NOT put the hydrion paper in the mouth.
   - Sweat
   - Water
   - Various soaps
   - Alcohol

- Bleach
- Salt
- Fruits
- Vegetables
- Milk
- Meats
- Oil

5. **Have the students summarize their test results. Make a class chart on acids and bases.**

Have them
- Use a pH scale of 1 to 14 to record test results.
- Label the point where things move from acid to base.
  ✔ This is the center neutral point of 7.
- Label the end of the scale with the greatest concentration of acid.
  ✔ This is the low or 1 end of the scale.
- Label the end of the scale with the greatest concentration of base.
  ✔ This is the high or 14 end of the scale.

6. **Have the class discuss their findings.**

Ask such questions as these:
- Which substance that you tested had the lowest pH?
- Which substance that you tested had the highest pH?
- What is the point on the scale where things go from acid to base?
  ✔ This is pH 7. Things with a pH 7 are called **neutral** substances.
- What thing(s) did you test that had a pH of about 7?
  ✔ Water and table salt or sugar solutions have pHs of about 7.

- What were the pHs of most of the living things you tested?
  ✔ Most are acid to neutral.

EXTENSIONS

- Set up an acid-base testing center. Have the students test and record the pH of additional substances they collect.
- Have the students research to find what acids and bases are used in cooking.
- Have the students investigate the use of red cabbage extract, litmus paper, and other acid-base indicators to test for acids and bases.

DASH

ACIDS AND BASES
SP 3.10.2

Name: ______________________

Date: ______________________

pH SCALE

1	2	3	4	5	6	7	8	9	10	11	12	13	14

TESTING FOR ACIDS AND BASES

SUBSTANCE TESTED	pH	ACID or BASE?

3.10.3 ACID AND BASE REACTIONS

OBJECTIVES

The students
- Investigate the reaction of various substances with acids.
- Investigate the reaction of various substances with bases.
- Observe the change in pH during reactions.

BACKGROUND

This is the third activity in the acid-base series. The students observe how an acid and a base react with different kinds of materials. White vinegar is the acid used and a dishwasher soap solution is used as the base. These are strong chemicals and should be handled with care. Alternatively, lemon or lime juice can be used as the acid and a limewater or strong soap solution as the base.

Dishwasher soap, limewater, lemon or lime juice, and vinegar are irritants and can burn the hands and clothing if not washed off quickly with plenty of water. **Goggles** and a **plastic apron** should **always** be worn when handling these chemicals.

To prepare the base solution, dissolve 25 mL (5 teaspoons) of dishwasher soap in 250 mL (1 cup) of water in a glass jar. Do not mix in a metal container. Shake thoroughly and let the solution stand overnight. Skim off any film from the top. Pour the clear liquid into a clean jar and label it Standard Base Solution. To make limewater add builder's lime, calcium hydroxide ($Ca(OH)_2$), to water until no more will dissolve. Shake well and allow the solution to stand for 24 hours. Pour off the clear liquid (limewater) and keep it in a tightly closed glass container until needed.

Use undiluted white vinegar (acetic acid) or strained lemon or lime juice (citric acid) as the acid in this activity.

To test materials in acids and bases, pour 10–20 mL of the acid or base solution into a small glass jar. The jar is the reaction chamber. Do not put lids on the chambers because opening may result in spills. Some

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items for testing are listed in the following chart. Students may add other items to the list.

ITEM	**Expected Reactions**	
	In Acid Solution	**In Base Solution**
Meat	Changes color and texture	Changes color and texture
Cloth	Weakens or disintegrates	Weakens or disintegrates. Bases strengthen cotton fabric in a process called mercerizing.
Baking soda (Sodium bicarbonate)	Forms a gas	No reaction
Milk	Curdles	Curdles
Fat	Changes color and texture	Turns pasty
Vegetables	Change color and texture	Change color and texture
Galvanized nail	Produces a gas and changes color	No reaction
Paper clip	Produces a gas and changes color	No reaction
Aluminum foil	No reaction	May form gas
Piece of tin can	Changes color if scratched	No reaction
Limestone	Produces a gas	No reaction
Copper sulfate	No reaction	Forms a precipitate

This activity can be done as a demonstration with some class participation. Ideally a pair of students will be responsible for each jar, its contents, and its observation. When the students handle or observe the contents closely they should wear aprons and goggles. Students can make their own aprons from heavy plastic bags. A student-made safety helmet can be used in place of goggles. See Activity 3.10.13 SAFETY EQUIPMENT.

If students get either acids or bases on their clothes or any part of their bodies, including eyes, wash with large quantities of running water.

These chemicals can be disposed of in the sink. Neither the acid or base solutions used in this activity will affect the plumbing or pollute the sewer system.

STUDENT ROLE

Chemist

MATERIALS

goggles (See Activity 3.10.13 SAFETY EQUIPMENT.)
plastic aprons (See Activity 3.10.13 SAFETY EQUIPMENT.)
white vinegar (acetic acid) or lemon or lime juice (citric acid)
dishwasher soap or builder's lime ($Ca(OH)_2$)
water
measuring containers (See Activity 3.10.12 MEASURING DEVICES.)
baby food or small glass jars (2 for each material to be tested)
glass jars for acid and base stock solutions.
materials to be tested
hydrion or pH paper
Student Page 3.10.3 ACID AND BASE REACTIONS

PRODUCT

Completed Student Pages

PROCEDURE

1. **Introduce the class to the idea of investigating what acids and bases do to the things around us. Discuss the safe use of acid and base solutions.**

   Ask such questions as these:
   - Does anyone have an idea about what an acid or a base might do to our clothes or skin?
     ✔ Work to the idea that it can burn them.

   - How can we protect ourselves?
     ✔ Get at the need to wear eye protection and aprons.

   - What should we do if we get an acid or a base on us?
     ✔ Wash it off with lots of water and tell the teacher.

   - What could we put acids and bases in to handle them?
     ✔ Work to the idea of using glass or plastic containers.

- What do you want to observe acids and bases reacting with?
  ✔ Introduce the word **reacting** as referring to what happens when things come in contact with each other.

2. **Have the students list and collect the materials they want to observe reacting with acids and bases.**

Help them include such things as

- Meat
- Cloth
- Baking soda
  ✔ sodium bicarbonate
- Milk
- Fat
- Vegetables
- Galvanized nail
- Paper clip
- Piece of aluminum
- Piece of tin can
- Limestone
- Copper sulfate

3. **Have the students wear goggles and aprons to investigate the acid reactions. Have each pair pour 10–20 mL of the acid into a baby food jar. Then have them add their material to the jar and observe what happens. Use SP 3.10.3 ACID AND BASE REACTIONS.**

Have them make and record such observations as

- Starting pH using hydrion paper.
- Changes in the material after 10 minutes
- Changes in the pH after 10 minutes

- Changes in the material every hour until the end of the day.

- Changes in the pH every hour until the end of the day.

- Changes in the material over night.

- Changes in the pH overnight.

4. **Have the students slowly fill the baby food jars with water and remove their materials. Have them test the materials to see whether they recorded all the changes that occurred.**

5. **Have the students wear goggles and aprons to investigate base reactions. Have each pair pour 10–20 mL of the base solution into a baby food jar. Then have them add their materials to the jar and observe what happens.**

   Have them make and record such observations as
   - Starting pH using hydrion paper.

   - Changes in the material after 10 minutes.

   - Changes in the pH after 10 minutes.

   - Changes in the material every hour until the end of the day.

   - Changes in the pH every hour until the end of the day.

   - Changes in the material overnight.

   - Changes in the pH overnight.

6. **Have the students slowly fill the baby food jars with water and remove their materials. Have them test the materials to see whether they recorded all the changes that occurred.**

7. **Summarize the activity with the class.**

   Ask such questions as these:
   - What happened to the pH of the base over the day and night?
     ✔ It should have gotten lower—closer to the neutral 7.

   - What does this mean?
     ✔ Work to the idea that the base gets weaker. There is less and less base.

- What happened to the pH of the acid over the day and night?
  ✔ It should have gotten higher—closer to the neutral 7.

- What does this mean?
  ✔ Work to the idea that the acid gets weaker. There is less and less acid.

- What happened to each of the items in the jars?
  ✔ With most materials there will have been some reaction with the acid, the base, or both.

EXTENSIONS

Have the students

- Research other kinds of acids and bases.

- Set up an acid and base reaction center to test other substances. This should be done under direct teacher supervision. Seal the baby food jars with lids. Only the teacher should open the jars for cleaning and emptying.

DASH

ACID AND BASE REACTIONS
SP 3.10.3

Name: ______________________

Date: ______________________

ACID REACTIONS

TEST MATERIAL	TIME	OBSERVATIONS	pH

BASE REACTIONS

TEST MATERIAL	TIME	OBSERVATIONS	pH

DASH

GRADE 4

ACTIVITY PLANS

Carol's Grade 4 Essential Activities

4.1.1-LC 4.1.2-Resp Ct 4.1.3-Last Yr 4.1.6-Goals 4.1. 8-Plans 4.1.9-C&S I	4.2.1-WeathSt 4.2.3-WindDir 4.2.4-WindSp 4.2.7-Cld&We 4.2.10-WMaps 4.2.11-WFrts 4.2.12-PredW 4.2.13-WndCh 4.2.14-Fl/Rd 4.2.17-Planm 4.2.18-UsePlm 4.2.23-SeasSn 4.2.24-Moon (4.2.2-Snow)	4.3.1-Pets 4.3.10-EarYrs 4.3.18-MdDig 4.3.19-DSy2D 4.3.20-DCRSy	4.4.1-AnBiPPl	4.5.2-MDig 4.5.4-FdGrp
4.6.1-Grow 4.6.2-Tooth 4.6.3-SafGr 4.6.8-AlToDr	4.7.1-BtDes 4.7.2-Wd&Sls	4.8.3-StrLng	4.9.1-BurDig (4.9.2-Recyc)	4.10.1-LinM 4.10.2-VolM 4.10.3-MassM

Grade 4 DASH: Suggested Year 1 Activity Plan

CLUSTER	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE
1. Learning	4.1.1-2-LC&RespC	4.1.1-2-LC 4.1.3-LstYr 4.1.8-ClsPlnCal	4.1.1-3,8	4.1.1-3,8	4.1.1-3,8	4.1.1-3,8 4.1.6-Gls (4.1.10-C&SI)	4.1.1-3,8	4.1.1-3,8	4.1.1-3,8	4.1.1-3,8	4.1.1-3 4.1.6-Gls 4.1.10-C&SInv
2. Time, Weather, & Sky		4.2.1-Rain 4.2.3-4-Wd	4.2.7-Clds		4.2.13-WdCh	4.2.24-Moon	4.2.10-12-WMps,Frt, PredWeath (4.2.2-Sn)	4.2.17-18-Planetrm 4.2.14-Flt/RndE?		4.2.23-Seas&Sun	
3. Animals	4.3.1-Pets			4.3.18-20-DigSy		4.3.10-EarlyYrs					
4. Plants									4.4.1-AnBiPPlts		
5. Food and Nutrition				4.5.4-FdGrp 4.5.2-MechDig							
6. Health and Safety	4.6.1-GrwthCht		4.6.3-SafEq			4.6.8-AlToDr	4.6.2-Teeth				4.6.1-GrwthCht
7. Way-finding										4.7.1-2-Boats	
8. Energy & Communi-cation										4.8.3-Strming	
9. Conserv., Recycling, & Decompos.			4.9.1-Bury			(4.9.2-Recyc)					4.9.1-DigUp
10. Matter, Space, & Construction			4.10.1-LinMeas			4.10.3-MassMeas			4.10.2-VolMeas		
NOTES	LearnCal Records Start Up	Weather	Clouds Decomp.	Food Grps Digestion		Moon Mass	Weather	Astronomy	Plants	Boats	Finish Up

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DASH Activities School Year Planning Form

CLUSTER	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE
1. Learning											
2. Time, Weather, & Sky											
3. Animals											
4. Plants											
5. Food and Nutrition											
6. Health and Safety											
7. Way-finding											
8. Energy & Communication											
9. Conserv., Recycling, & Decompos.											
10. Matter, Space, & Construction											
NOTES and ORGANIZING IDEAS											

DASH

GRADE 4

SCOPE & SEQUENCE

ACTIVITY LISTS

GRADES K–5 DASH SCOPE AND SEQUENCE OF ACTIVITIES

CLUSTER	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4	GRADE 5
Learning	Learning Calendar Home Learning Calendar Calendar Review Responsibility Chart Science Record Book Using Our Senses Same and Different Physical Characteristics Functions of Things Working Dictionary Wonder and Discover Book Connections Book Families Families and Helping Making Friends Being Friends School and Home Concept and Skill Inventory	Learning Calendar Responsibility Chart Planning Calendar Last Year Helping Working Together Taking Turns and Sharing Concept and Skill Inventory	Learning Calendar Last Year Aphorisms Helping Others Getting Help Making and Keeping Friends Turns School, Teacher, Friends, and Family Predictions about Tomorrow Planning for Tomorrow Thinking Library Concept and Skill Inventory	Learning Calendar Last Year Responsibility Planning Organizing Our Environment Friends Giving and Receiving Working Together Helping Myself and Others Aphorisms Next Year Science & Technology Concept and Skill Inventory	Learning Calendar Responsibility Last Year Library Working Together Things I Can Do for Myself and Others Aphorisms Planning Survival Game Concept and Skill Inventory	Learning Calendar Responsibility Library Working Together Things I Can Do for Myself and Others Aphorisms Friendship Concept and Skill Inventory
Time, Weather, and Sky	Weather Watch Beginnings Endings Day and Night Days, Weeks, and Months Moon Watch Moon Phases Seasons Clocks and Calendars	Sky and Weather Watch Rain and Streams Snow and Streams Digital Clock Hours and Minutes Time Line Sunrise and Sunset Night and Day The Sun The Seasons Making a Clock Moonrise & Moonset	Temperature Wind Sunrise, Sunset, and Seasons Moonrise and Moonset Rain Snow Digital Time Analog Time	Weather Temperature Wind Rain and Snow Humidity Sunrise and Sunset Moon Phases Polar Sky Model Polar Constellations Venus Eclipses	Rainfall and Snowfall Wind Direction & Speed Height of Clouds Clouds and Weather Storm Clouds Humidity and Wind Chill Lightning Weather Maps Weather Fronts Predicting Weather Flat or Round Earth? Length of Day and Night The Sun's Shadow Path The Planetarium Planets When Is It Noon? Making and Using a Sundial Seasons and the Sun Moon Phases and the Sun Eclipses	Weather Station Heat Index Weather Prediction Clouds and Fronts Triangles Gnomon Size of Earth Moon Through a Telescope How Big and Far Away Is the Moon? Paths of Celestial Bodies Models of the Solar System

GRADES K–5 DASH SCOPE AND SEQUENCE OF ACTIVITIES

CLUSTER	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4	GRADE 5
Animals	Appropriate Pets Classroom Animals Caring for Animals Living, Once-living, and Nonliving Things Animals and Plants Animal Environments Uses for Animals How Bugs Walk Parts of Bugs Parts of Mammals People Animals and Food Animals and Water Animals and Air Animal Wastes How Animals Keep Warm How Animals Keep Cool Real or Imaginary	Classroom Pets Living &and Nonliving Things Defining Living and Nonliving Things Animal Survey Animal Key Animal Needs Planning to Raise a Small Animal Building Cages Metamorphosis	Classroom Pets Classroom Aquarium External Anatomy of Fish Biological Needs of Fish Reproduction and Development of Fish Finding Insect Eggs Hatching Insect Eggs Early Metamorphosis Late Metamorphosis Collecting Spiders Insects and Spiders Spider Food Spider Care Spiders as Predators Spider Webs	Classroom Pets Raising Insects Comparing Insects Importance of Insects Frog and Toad Habitats Raising Frogs and Toads Frog Metamorphosis Importance of Frogs and Toads Toads and Insects Hatching Chicks Chick Growth Importance of Birds	Pet Care Unincubated Egg Chick Embryology Raising Small Mammals Reproduction of Pet Mammals Pet Baby Care Our Early Years The First Grade Child Development of Pets Human Development Changing Dimensions Anatomy of Fish Fish Reproduction Digestive, Circulatory, and Reproductive Systems Migration and Hibernation Fall, Winter, and Spring Birds	Pet Care Birds I Know Cells Male Urogenital System Female Urogenital System Ovulation Cycle Ovulation and Pregnancy Embryology Body Changes Bones Skeletal System Muscles Muscular System Chemistry and Bones The Senses The Eye Sound The Ear
Plants	Plant Parts Plant Environment Plant Uses Growing Bean Sprouts Plants and Water Gardening	Plant Identification Plant Survey Plant Pressing Plant Key Plant Needs Plant Life Cycle Edible Plant Parts Plant Parts Animals Eat	Soil Making Soil Soil and Plants Soil Uses Finding Soil Pipes and Water Moving Water: Gravity Moving Water: Pumps Vegetable and Flower Gardens in a Bucket Rooting Stems Rooting Bulbs and Tubers Roots and Water Growing Root Vegetables Tree Planting	Garden Planning Garden Preparation Watching Garden Soil Making Artificial Soil Testing Soil Soil and Water Garden Planting Garden Care Watering Systems Garden Invaders Controlling Insects Garden Harvesting Flowers Seeds Pollination	Annual, Biennial, and Perennial Plants Fungi	Annual, Biennial, and Perennial Plant Project Tree Harvesting Tree Planting Tree Observation Measuring Trees Age of Trees Trees, Shrubs, and Grasses Grasses: Why Do They Grow There? Roots Soil Conservation
Food and Nutrition	Bean Sprout Salad Drinks Flour and Bread Familiar Foods Favorite Foods New Foods Garden Snack Foods	Food Groups Cooking Measuring Volume	Supermarket Survey Food Preference Food Groups New Foods Properties of Foods Changing Flavor Milk, Butter, and Cheese Energy from Food	Nutritious Food Selection Plants for the Garden Class Feast Drying and Pickling Foods Preserving and Rotting Supermarket Game Pricing Foods Food Ads	Nutrients Mechanical Digestion Chemical Digestion Food Groups Preserving Foods	Nutrients Nutrients and Cells Food Labeling

GRADES K–5 DASH SCOPE AND SEQUENCE OF ACTIVITIES

CLUSTER	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4	GRADE 5
Health and Safety	Growth Chart Tooth Chart Tooth Care Exercise Germs Washing Hands Bathrooms and Basins Aprons Fountains and Faucets Getting Sick Feeling Sick Going to the Doctor What Doctors Do Going to the Hospital Raincoats Testing Raincoats Wet and Cold Keeping Warm Indoors Hand and Foot Protection Getting Lost	Growth Chart Tooth Chart Brushing Teeth Chewing Air and Breathing Getting Hurt Staying Healthy Safety Rules	Growth Chart Tooth Chart Tooth Care Getting Hurt Getting Sick Staying Well Classroom and Playground Safety Fire Safety Using 911	Growth Chart Tooth Chart Breathing Air Anatomy of Breathing Lung Model Lungs and Smoking Breathing and Pulse Heart, Veins, and Arteries Heart, Lungs, and Exercise Disease Transmission Trash and Sanitation Helpful Drugs Proper Drug Use	Growth Chart and Area Measurement Tooth Chart Safety Gear Safety and Putting Out Fires Making a Fire Things That Burn Smoking and the Lungs Alcohol, Tobacco, and Drugs	Growth Chart and Area Measurement Tooth Chart Alcohol, Tobacco, and Drugs Sexually Transmitted Diseases Safety Devices Smokers' Surveys Smoking Laws Alcohol Laws Chris's Story The Parents' Story Intoxication Drug Laws
Wayfinding and Transportation	Right and Left Sunrise Sunset North and South Home Location Sidewalks & Walkways Roads Traffic Simulation Equipment Traffic Simulation Mapping Traffic Rules Classroom Mapping	Pacing North, South, East, and West Home Map Distance Making a Boat Making a Lake The Great Regatta Floating and Sinking Draining a Lake	Transportation Systems Making Race Cars Racing Cars Roads Building a Village Pedestrians in the Village Bikes in the Village Cars in the Village Bikes and Trikes Belts and Pulleys Fast and Slow Pulleys Gears and Wheels	Garden Mover Propeller-Driven Message Center Propeller-driven Boat Delivery Systems	Boat Design Wind and Sails	Where in the World Are We? Planetarium Mapping the Sky The North Pole, Equator, and Ecliptic Where Is Earth?

GRADES K–5 DASH SCOPE AND SEQUENCE OF ACTIVITIES

CLUSTER	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4	GRADE 5
Energy and Communication	Energy Making Things Move Making Things Stop Turning Things Off Turning Things On Repairing Things	Temperature of Things Master Thermometer Hot and Cold Sources of Energy	Sun and Direction Mirrors and Sunlight Clouds and Sunlight Comparing Temperatures Eclipses	Shadow, Light, and Bubbles Wind and Heat Wind Pulls and Pushes Propellers Driving Propellers Waterwheels Propellers in Water Heliograph Speaking Tube String Telephone Energy Definitions	Push-Pull Measuring Tool Friction Streamlining Pressure, Sharp Edges, and Points Energy of Falling Objects Circles and Speed	Pushes, Pulls, & Forces Teeter-Totters The Balance Wheels and Axles Levers Arms and Jaws Inclined Planes and Screws Block and Tackle Magnetic Pushes and Pulls Magnets and Compasses Magnetic Fields Forces Projects
Conservation, Recycling, and Decomposition	Decomposition Waste Disposal Recycling Project Making Paper	Classroom Resources Conserving Energy Conserving Water Decomposition and Unearthing Decomposition and Reburial Recycling	Fall Unearthing Fall Burying Spring Unearthing Spring Burying Pollution Survey Aluminum Recycling Connections	Making Compost Watching Compost Animals in Compost Using Compost Fall Unearthing and Burial Spring Unearthing and Burial	Unearthing and Burial Recycling Project	Class Recycling Project Class Conservation Project Decomposition and Archeology Pollution Project
Matter, Space, and Construction	Cubby Organization Patterns in Puzzles Making Puzzles Making Envelopes Making Boxes and Bags Volume of Boxes and Bags Packing and Storing Linear Measurement	Meter-string Can Outdoor Study Area Mapping Testing for Water Measuring Volume Plumbing Water Systems Air Bubbles in Water and Air Building with Air Floor Plan Cardboard House Plan Making a Cardboard House Painting the House Furnishing the House Sewing and Weaving Warming andCooling Lighting the House Safety Equipment	Desk Organization Notebook Organization The Balance Meter-string Can Measuring Volume Safety Equipment	Acidic and Basic Soil Acids and Bases Acid and Base Reactions Diluting Acids and Bases Acid and Base Interactions Dissolving Things Things in Liquids Crystals Rain in a Jar Supermarket Planning Supermarket Construction Measuring Devices Safety Equipment	Linear Measurement Volume Measurement Mass Measurement Collecting Rocks Hardness of Rocks Specific Gravity Rocks and Sharp Edges Making Tools from Rock Clowns: Things That Float Clay Fire and Pottery Air and Fire Fire and Oxygen Properties of Gas	Linear Measurement Volume Measurement Mass Measurement Camera Obscura Controlling Light with Lenses Making a Telescope Stabilizing the Telescope Making a Microscope Making a Hygrometer Making a Barometer

GRADE 6 SCOPE AND SEQUENCE OF ACTIVITIES

Learning	Time, Weather, and Sky	Animals	Plants	Food and Nutrition
Learning Calendar Last Year Mars Mission Tomorrow The Work World Goals Crash Simulation Mars Compact Martian Simulation The Mission Conference Concept and Skill Inventory	Weather Station Weather Around the United States Weather and Local Climate Wind Hypotheses Producing Winds Air Pressure and Altitude Wind and Water Altitude and Temperature Models of Air Climatic Regions Climate of Mars	Animal Care Raising Fish Raising Worms Food Chains	Hydroponics Algae Nutrients and Biological Waste Water Pollutants	Nutrient Tables The Kilocalorie Weight Watching Meal Planning Food for Space Fish for Dinner
Health and Safety	**Wayfinding and Transportation**	**Energy and Communication**	**Conservation, Recycling, and Decomposition**	**Matter, Space, and Construction**
Growth Chart Tooth Chart Safety Disease Literature Sanitation Disease Prevention and Treatment Sexually Transmitted Diseases Drug Abuse Prevention and Treatment Alcohol and Tobacco Environmental Disease Transmission, Prevention, and Treatment Exercise and Health and the Mars Mission	Flying Airplanes Flying Rockets Spacecraft The Orbit of Mars What Path to Mars?	Rocket Propulsion Magnetism Electrostatics Electrical Circuits Rock Formation Metals from Ores Asymmetrical Levers	Recycling Project Conservation Decomposition: A Summary Pollution	Making Measuring Equipment Making a Balance Making an Electroscope Making Electromagnets and Current Indicators Making Electric Cells Making an Electric Motor Making an Electric Signaler Making a Martian Survival Habitat

GRADE K

CLUSTER 1 LEARNING

K.1.1 THE LEARNING CALENDAR
K.1.2 THE CLASS RESPONSIBILITY CHART
K.1.3 CALENDAR REVIEW
K.1.4 THE HOME LEARNING CALENDAR
K.1.5 THE SCIENCE RECORD BOOK
K.1.6 USING OUR SENSES
K.1.7 SAME AND DIFFERENT
K.1.8 PHYSICAL CHARACTERISTICS OF THINGS
K.1.9 FUNCTIONS OF THINGS
K.1.10 THE WORKING DICTIONARY AND WORKING DEFINITIONS
K.1.11 THE WONDER AND DISCOVER BOOK
K.1.12 THE CONNECTIONS BOOK
K.1.13 FAMILIES
K.1.14 FAMILIES AND HELPING
K.1.15 MAKING FRIENDS
K.1.16 BEING FRIENDS
K.1.17 SCHOOL AND HOME
K.1.18 CONCEPT AND SKILL INVENTORY

CLUSTER 2 TIME, WEATHER, AND SKY

K.2.1 WEATHER WATCH
K.2.2 BEGINNINGS
K.2.3 ENDINGS
K.2.4 DAY AND NIGHT
K.2.5 DAYS, WEEKS, AND MONTHS
K.2.6 MOON WATCH
K.2.7 MOON PHASES
K.2.8 SEASONS
K.2.9 CLOCKS AND CALENDARS

CLUSTER 3 ANIMALS

K.3.1 APPROPRIATE PETS
K.3.2 CLASSROOM ANIMALS
K.3.3 CARING FOR CLASSROOM ANIMALS
K.3.4 LIVING, ONCE-LIVING, AND NON-LIVING
K.3.5 ANIMALS AND PLANTS
K.3.6 ANIMAL ENVIRONMENTS
K.3.7 USES FOR ANIMALS
K.3.8 HOW BUGS WALK
K.3.9 PARTS OF BUGS
K.3.10 PARTS OF MAMMALS
K.3.11 PEOPLE
K.3.12 ANIMALS AND FOOD
K.3.13 ANIMALS AND WATER
K.3.14 ANIMALS AND AIR
K.3.15 ANIMAL WASTES
K.3.16 HOW ANIMALS KEEP WARM
K.3.17 HOW ANIMALS KEEP COOL
K.3.18 REAL OR IMAGINARY

CLUSTER 4 PLANTS

K.4.1 PLANT PARTS
K.4.2 PLANT ENVIRONMENTS
K.4.3 PLANT USES
K.4.4 GROWING BEAN SPROUTS
K.4.5 PLANTS AND WATER
K.4.6 GARDENING

CLUSTER 5 FOOD AND NUTRITION

K.5.1 BEAN SPROUT SALAD
K.5.2 DRINKS
K.5.3 FLOUR AND BREAD
K.5.4 FAMILIAR FOODS
K.5.5 FAVORITE FOODS
K.5.6 NEW FOODS
K.5.7 SNACKS FROM THE GARDEN

CLUSTER 6 HEALTH AND SAFETY

K.6.1 GROWTH CHART
K.6.2 TOOTH CHART
K.6.3 TOOTH CARE
K.6.4 EXERCISE
K.6.5 GERMS
K.6.6 WASHING HANDS
K.6.7 BATHROOMS AND BASINS
K.6.8 APRONS
K.6.9 FOUNTAINS AND FAUCETS
K.6.10 GETTING SICK
K.6.11 FEELING SICK
K.6.12 GOING TO THE DOCTOR
K.6.13 WHAT DOCTORS DO
K.6.14 GOING TO THE HOSPITAL
K.6.15 RAINCOATS
K.6.16 TESTING RAINCOATS
K.6.17 WET AND COLD
K.6.18 KEEPING WARM INDOORS
K.6.19 KEEPING COOL INDOORS
K.6.20 HAND AND FOOT PROTECTION
K.6.21 GETTING LOST

CLUSTER 7 WAYFINDING AND TRANSPORTATION

K.7.1 RIGHT AND LEFT
K.7.2 SUNRISE
K.7.3 SUNSET
K.7.4 NORTH AND SOUTH
K.7.5 HOME LOCATION
K.7.6 SIDEWALKS AND WALKWAYS
K.7.7 ROADS
K.7.8 TRAFFIC SIMULATION EQUIPMENT
K.7.9 TRAFFIC SIMULATION MAPPING
K.7.10 TRAFFIC RULES
K.7.11 CLASSROOM MAPPING

CLUSTER 8 ENERGY AND COMMUNICATION

K.8.1 ENERGY
K.8.2 MAKING THINGS MOVE
K.8.3 MAKING THINGS STOP
K.8.4 TURNING THINGS OFF
K.8.5 TURNING THINGS ON
K.8.6 REPAIRING THINGS

CLUSTER 9 CONSERVATION, RECYCLING, AND DECOMPOSITION

K.9.1 DECOMPOSITION
K.9.2 WASTE DISPOSAL
K.9.3 RECYCLING PROJECT
K.9.4 MAKING PAPER

CLUSTER 10 MATTER, SPACE, AND CONSTRUCTION

K.10.1 CUBBY ORGANIZATION
K.10.2 PATTERNS IN PUZZLES
K.10.3 MAKING ENVELOPES
K.10.4 MAKING PUZZLES
K.10.5 MAKING BOXES AND BAGS
K.10.6 VOLUME OF BOXES AND BAGS
K.10.7 PACKING AND STORING
K.10.8 LINEAR MEASUREMENT

GRADE 1

CLUSTER 1 LEARNING

1.1.1 THE LEARNING CALENDAR
1.1.2 THE RESPONSIBILITY CHART
1.1.3 THE PLANNING CALENDAR
1.1.4 THINGS LEARNED LAST YEAR
1.1.5 HELPING
1.1.6 WORKING TOGETHER
1.1.7 TAKING TURNS AND SHARING
1.1.8 CONCEPT AND SKILL INVENTORY

CLUSTER 2 TIME, WEATHER, AND SKY

1.2.1 SKY AND WEATHER WATCH
1.2.2 RAIN AND STREAMS
1.2.3 SNOW AND STREAMS
1.2.4 THE DIGITAL CLOCK
1.2.5 HOURS AND MINUTES
1.2.6 TIME LINE
1.2.7 SUNRISE AND SUNSET
1.2.8 NIGHT AND DAY
1.2.9 THE SUN
1.2.10 THE SEASONS
1.2.11 MAKING A CLOCK
1.2.12 MOONRISE AND MOONSET

CLUSTER 3 ANIMALS

1.3.1 LIVING AND NON-LIVING THINGS
1.3.2 DEFINING LIVING AND NON-LIVING THINGS
1.3.3 ANIMALS SURVEY
1.3.4 ANIMALS KEY
1.3.5 ANIMALS NEEDS
1.3.6 PLANNING TO RAISE A SMALL ANIMAL
1.3.7 BUILDING CAGES
1.3.8 METAMORPHOSIS
1.3.9 CLASSROOM PETS

CLUSTER 4 PLANTS

1.4.1 PLANT IDENTIFICATION
1.4.2 PLANT SURVEY
1.4.3 PLANT PRESSING
1.4.4 PLANT KEY
1.4.5 PLANT NEEDS
1.4.6 PLANT LIFE CYCLE
1.4.7 EDIBLE PLANT PARTS
1.4.8 PLANT PARTS ANIMALS EAT

CLUSTER 5 FOOD AND NUTRITION

1.5.1 BASIC THREE FOOD GROUPS
1.5.2 COOKING
1.5.3 MEASURING VOLUME

CLUSTER 6 HEALTH AND SAFETY

1.6.1 GROWTH CHART
1.6.2 TOOTH CHART
1.6.3 BRUSHING TEETH
1.6.4 CHEWING
1.6.5 AIR AND BREATHING
1.6.6 GETTING HURT
1.6.7 STAYING HEALTHY
1.6.8 SAFETY RULES

CLUSTER 7 WAYFINDING AND TRANSPORTATION

1.7.1 PACING
1.7.2 NORTH, SOUTH, EAST, AND WEST
1.7.3 HOME
1.7.4 MAP DISTANCE
1.7.5 MAKING A BOAT
1.7.6 MAKING A LAKE
1.7.7 THE GREAT REGATTA
1.7.8 FLOATING AND SINKING
1.7.9 DRAINING A LAKE

CLUSTER 8 ENERGY AND COMMUNICATION

1.8.1 TEMPERATURE OF THINGS
1.8.2 THE MASTER THERMOMETER
1.8.3 HOT AND COLD
1.8.4 SOURCES OF ENERGY

CLUSTER 9 CONSERVATION, RECYCLING, AND DECOMPOSITION

1.9.1 CONSERVING CLASSROOM RESOURCES
1.9.2 CONSERVING ENERGY
1.9.3 CONSERVING WATER
1.9.4 DECOMPOSITION AND UNEARTHING
1.9.5 DECOMPOSITION AND REBURIAL
1.9.6 RECYCLING

CLUSTER 10 MATTER, SPACE, AND CONSTRUCTION

1.10.1 METER–STRING CAN
1.10.2 OUTDOOR STUDY AREA MAPPING
1.10.3 TESTING FOR WATER
1.10.4 PLUMBING
1.10.5 WATER SYSTEMS
1.10.6 AIR
1.10.7 BUBBLES IN WATER
1.10.8 BUBBLES IN AIR
1.10.9 BUILDING WITH AIR
1.10.10 FLOOR PLAN
1.10.11 FLOOR PLAN MODEL
1.10.12 CARDBOARD HOUSE PLAN
1.10.13 MAKING A CARDBOARD HOUSE
1.10.14 PAINTING THE HOUSE
1.10.15 FURNISHING THE HOUSE
1.10.16 SEWING
1.10.17 WEAVING
1.10.18 WARMING AND COOLING THE HOUSE
1.10.19 LIGHTING THE HOUSE
1.10.20 SAFETY EQUIPMENT

GRADE 2

CLUSTER 1 LEARNING

2.1.1 THE LEARNING CALENDAR
2.1.2 LAST YEAR
2.1.3 APHORISMS
2.1.4 HELPING MYSELF AND OTHERS
2.1.5 GETTING HELP
2.1.6 MAKING AND KEEPING FRIENDS
2.1.7 TURNS
2.1.8 SCHOOL, TEACHER, FRIENDS, AND FAMILY
2.1.9 PREDICTIONS ABOUT TOMORROW
2.1.10 PLANNING FOR TOMORROW
2.1.11 THINKING
2.1.12 LIBRARY
2.1.13 CONCEPT AND SKILL INVENTORY

CLUSTER 2 TIME, WEATHER, AND SKY

2.2.1 TEMPERATURE
2.2.2 WIND
2.2.3 SUNRISE, SUNSET, AND SEASONS
2.2.4 MOONRISE AND MOONSET
2.2.5 RAIN
2.2.6 SNOW
2.2.7 DIGITAL TIME
2.2.8 ANALOG TIME

CLUSTER 3 ANIMALS

2.3.1 THE CLASSROOM AQUARIUM
2.3.2 EXTERNAL ANATOMY OF FISH
2.3.3 BIOLOGICAL NEEDS OF FISH
2.3.4 REPRODUCTION AND DEVELOPMENT OF FISH
2.3.5 FINDING INSECT EGGS
2.3.6 HATCHING INSECT EGGS
2.3.7 EARLY METAMORPHOSIS
2.3.8 LATE METAMORPHOSIS
2.3.9 COLLECTING SPIDERS
2.3.10 SPIDER FOOD
2.3.11 SPIDER CARE
2.3.12 SPIDERS AS PREDATORS
2.3.13 SPIDER WEBS
2.3.14 CLASSROOM PETS

CLUSTER 4 PLANTS

2.4.1 SOIL
2.4.2 MAKING SOIL
2.4.3 SOIL AND PLANTS
2.4.4 SOIL USES
2.4.5 FINDING SOIL
2.4.6 PIPES AND WATER
2.4.7 MOVING WATER WITH GRAVITY
2.4.8 MOVING WATER WITH PUMPS
2.4.9 VEGETABLE GARDEN IN A BUCKET
2.4.10 FLOWER GARDEN IN A BUCKET
2.4.11 PLANTS AND SUNLIGHT
2.4.12 ROOTING STEMS
2.4.13 ROOTING BULBS AND TUBERS
2.4.14 ROOTS AND WATER
2.4.15 GROWING ROOT VEGETABLES
2.4.16 TREE PLANTING

CLUSTER 5 FOOD AND NUTRITION

2.5.1 SUPERMARKET SURVEY
2.5.2 FOOD PREFERENCES
2.5.3 BASIC THREE FOOD GROUPS
2.5.4 NEW FOODS
2.5.5 IDENTIFYING PROPERTIES OF VEGETABLES
2.5.6 CHANGING FLAVOR
2.5.7 MILK
2.5.8 BUTTER
2.5.9 CHEESE
2.5.10 ENERGY FROM FOOD

CLUSTER 6 HEALTH AND SAFETY

2.6.1 GROWTH CHART
2.6.2 TOOTH CHART
2.6.3 TOOTH CARE
2.6.4 GETTING HURT
2.6.5 GETTING SICK
2.6.6 STAYING WELL
2.6.7 CLASSROOM AND PLAYGROUND SAFETY
2.6.8 FIRE SAFETY
2.6.9 USING 911

CLUSTER 7 WAYFINDING AND TRANSPORTATION

2.7.1 TRANSPORTATION SYSTEMS
2.7.2 MAKING RACE CARS
2.7.3 RACING AND MODIFYING CARS
2.7.4 ROADS
2.7.5 BUILDING A VILLAGE
2.7.6 PEDESTRIANS IN THE VILLAGE
2.7.7 BIKES IN THE VILLAGE
2.7.8 CARS IN THE VILLAGE
2.7.9 BIKES AND TRIKES
2.7.10 BELTS AND PULLEYS
2.7.11 FAST AND SLOW PULLEYS
2.7.12 GEARS AND WHEELS

CLUSTER 8 ENERGY AND COMMUNICATION

2.8.1 CAMERA OBSCURA
2.8.2 MIRRORS AND SUNLIGHT
2.8.3 CLOUDS AND SUNLIGHT
2.8.4 COMPARING TEMPERATURES
2.8.5 ECLIPSES

CLUSTER 9 CONSERVATION, RECYCLING, AND DECOMPOSITION

2.9.1 FALL UNEARTHING
2.9.2 FALL BURYING
2.9.3 SPRING UNEARTHING
2.9.4 SPRING BURYING
2.9.5 POLLUTION SURVEY AND CLEANUP
2.9.6 ALUMINUM RECYCLING
2.9.7 CONNECTIONS

CLUSTER 10 MATTER, SPACE, AND CONSTRUCTION

2.10.1 DESK ORGANIZATION
2.10.2 NOTEBOOK ORGANIZATION
2.10.3 THE BALANCE
2.10.4 METER-STRING CAN
2.10.5 MEASURING VOLUME
2.10.6 SAFETY EQIPMENT

GRADE 3

CLUSTER 1 LEARNING

3.1.1 THE LEARNING CALENDAR
3.1.2 LAST YEAR
3.1.3 RESPONSIBILITY
3.1.4 PLANNING
3.1.5 ORGANIZING OUR ENVIRONMENT
3.1.6 FRIENDS
3.1.7 GIVING AND RECEIVING
3.1.8 WORKING TOGETHER
3.1.9 HELPING MYSELF AND OTHERS
3.1.10 APHORISMS
3.1.11 NEXT YEAR
3.1.12 CAREY'S GARDEN
3.1.13 CONCEPT AND SKILL INVENTORY

CLUSTER 2 TIME, WEATHER, AND SKY

3.2.1 WEATHER
3.2.2 TEMPERATURE
3.2.3 WIND
3.2.4 RAIN AND SNOW
3.2.5 HUMIDITY
3.2.6 SUNRISE AND SUNSET
3.2.7 MOON PHASES
3.2.8 POLAR SKY MODEL
3.2.9 POLAR CONSTELLATIONS
3.2.10 VENUS
3.2.11 ECLIPSES

CLUSTER 3 ANIMALS

3.3.1 CLASSROOM PETS
3.3.2 PREPARING TO RAISE INSECTS
3.3.3 RAISING INSECTS
3.3.4 IMPORTANCE OF INSECTS
3.3.5 NATURAL HABITATS OF FROGS AND TOADS
3.3.6 MAKING HABITATS FOR FROGS AND TOADS
3.3.7 FROG METAMORPHOSIS
3.3.8 IMPORTANCE OF FROGS AND TOADS
3.3.9 TOADS AND INSECTS
3.3.10 HATCHING CHICKS
3.3.11 CHICK GROWTH
3.3.12 IMPORTANCE OF BIRDS

CLUSTER 4 PLANTS

3.4.1 GARDEN PLANNING
3.4.2 GARDEN PREPARATION
3.4.3 WATCHING GARDEN SOIL
3.4.4 MAKING ARTIFICIAL SOIL
3.4.5 TESTING ARTIFICIAL SOIL
3.4.6 SOIL AND WATER
3.4.7 GARDEN PLANTING
3.4.8 GARDEN CARE
3.4.9 GARDEN WATERING SYSTEMS
3.4.10 GARDEN INVADERS
3.4.11 CONTROLLING INSECTS
3.4.12 GARDEN HARVESTING
3.4.13 FLOWERS
3.4.14 SEEDS
3.4.15 POLLINATION

CLUSTER 5 FOOD AND NUTRITION

3.5.1 FOOD SELECTION
3.5.2 SELECTING PLANTS FOR THE GARDEN
3.5.3 PLANNING THE CLASS FEAST
3.5.4 PREPARING THE CLASS FEAST
3.5.5 THE CLASS FEAST
3.5.6 DRYING FOODS
3.5.7 PICKLING FOODS
3.5.8 PRESERVING AND ROTTING
3.5.9 SUPERMARKET GAME PREPARATION
3.5.10 PRICING FOODS
3.5.11 NEWSPAPER ADS AND BANKING
3.5.12 FARMERS AND PROCESSORS
3.5.13 SUPERMARKET GAME

CLUSTER 6 HEALTH AND SAFETY

3.6.1 GROWTH CHART
3.6.2 TOOTH CHART
3.6.3 BREATHING AIR
3.6.4 ANATOMY OF BREATHING
3.6.5 LUNG MODEL
3.6.6 LUNGS AND SMOKING
3.6.7 BREATHING AND PULSE RATES
3.6.8 HEART, VEINS, AND ARTERIES
3.6.9 HEART, LUNGS, AND EXERCISE
3.6.10 DISEASE TRANSMISSION
3.6.11 TRASH AND SANITATION
3.6.12 HELPFUL DRUGS
3.6.13 PROPER DRUG USE

CLUSTER 7 WAYFINDING AND TRANSPORTATION

3.7.1 GARDEN MOVER
3.7.2 PROPELLER-DRIVEN MESSAGE CENTER
3.7.3 PROPELLER-DRIVEN BOAT
3.7.4 DELIVERY SYSTEMS

CLUSTER 8 ENERGY AND COMMUNICATION

3.8.1 SHADOW, LIGHT, AND BUBBLES
3.8.2 WIND AND HEAT
3.8.3 WIND PULLS AND PUSHES
3.8.4 PROPELLERS DRIVING PROPELLERS
3.8.5 WATERWHEELS
3.8.6 PROPELLERS IN WATER
3.8.7 HELIOGRAPH
3.8.8 SPEAKING TUBE
3.8.9 STRING TELEPHONE
3.8.10 ENERGY DEFINITIONS

CLUSTER 9 CONSERVATION, RECYCLING, AND DECOMPOSITION

3.9.1 MAKING COMPOST
3.9.2 WATCHING COMPOST
3.9.3 ANIMALS IN COMPOST
3.9.4 USING COMPOST
3.9.5 FALL UNEARTHING AND BURIAL
3.9.6 SPRING UNEARTHING AND BURIAL

CLUSTER 10 MATTER, SPACE, AND CONSTRUCTION

3.10.1 ACIDIC AND BASIC SOIL
3.10.2 ACIDS AND BASES
3.10.3 ACID AND BASE REACTIONS
3.10.4 DILUTING ACIDS AND BASES
3.10.5 ACID AND BASE INTERACTION
3.10.6 DISSOLVING THINGS
3.10.7 THINGS IN LIQUIDS
3.10.8 CRYSTALS
3.10.9 RAIN IN A JAR
3.10.10 SUPERMARKET PLANNING
3.10.11 SUPERMARKET CONSTRUCTION
3.10.12 MEASURING DEVICES
3.10.13 SAFETY EQUIPMENT

GRADE 4

CLUSTER 1 LEARNING

4.1.1 THE LEARNING CALENDAR
4.1.2 RESPONSIBILITY
4.1.3 LAST YEAR
4.1.4 THE LIBRARY
4.1.5 WORKING TOGETHER
4.1.6 THINGS I CAN DO FOR MYSELF AND OTHERS
4.1.7 APHORISMS
4.1.8 PLANNING
4.1.9 SURVIVAL GAME
4.1.10 CONCEPT AND SKILL INVENTORY

CLUSTER 2 TIME, WEATHER, AND SKY

4.2.1 RAINFALL
4.2.2 SNOWFALL
4.2.3 WIND DIRECTION
4.2.4 WIND SPEED
4.2.5 HEIGHT OF CLOUDS
4.2.6 HUMIDITY
4.2.7 CLOUDS AND WEATHER
4.2.8 STORM CLOUDS
4.2.9 LIGHTNING
4.2.10 WEATHER MAPS
4.2.11 WEATHER FRONTS
4.2.12 PREDICTING WEATHER
4.2.13 WIND CHILL
4.2.14 FLAT OR ROUND EARTH?
4.2.15 LENGTH OF DAY AND NIGHT
4.2.16 THE SUN'S SHADOW PATH
4.2.17 PLANETARIUM
4.2.18 USING THE PLANETARIUM
4.2.19 PLANETS
4.2.20 WHEN IS IT NOON?
4.2.21 MAKING A SUNDIAL
4.2.22 USING A SUNDIAL
4.2.23 SEASONS AND THE SUN
4.2.24 MOON PHASES AND THE SUN
4.2.25 ECLIPSE

CLUSTER 3 ANIMALS

4.3.1 PET CARE
4.3.2 THE UNINCUBATED EGG
4.3.3 CHICK EMBRYOLOGY
4.3.4 RAISING SMALL MAMMALS
4.3.5 HOUSING PET MAMMALS
4.3.6 WEEKEND CARE OF PET MAMMALS
4.3.7 PAIRING PET ANIMALS
4.3.8 REPRODUCTION OF PET MAMMALS
4.3.9 PET BABY CARE
4.3.10 OUR EARLY YEARS
4.3.11 THE FIRST GRADE CHILD
4.3.12 GROWTH, DEVELOPMENT, AND BEHAVIOR OF YOUNG PETS
4.3.13 HUMAN GROWTH AND DEVELOPMENT
4.3.14 CHANGING DIMENSIONS
4.3.15 EXTERNAL ANATOMY OF FISH
4.3.16 CLEANING FISH: INTERNAL ANATOMY
4.3.17 FISH REPRODUCTION
4.3.18 MODELING OUR DIGESTIVE SYSTEM
4.3.19 OUR DIGESTIVE SYSTEM IN TWO DIMENSIONS
4.3.20 DIGESTIVE, CIRCULATORY, AND RESPIRATORY SYSTEMS
4.3.21 LENGTH OF THE DIGESTIVE TRACT
4.3.22 MIGRATION AND HIBERNATION
4.3.23 FALL BIRDS
4.3.24 WINTER BIRDS
4.3.25 SPRING BIRDS

CLUSTER 4 PLANTS

4.4.1 ANNUAL, BIENNIAL, AND PERENNIAL GARDEN PLANTS
4.4.2 THE FUNGUS AMONG US
4.4.3 FUNGUS COLLECTION

CLUSTER 5 FOOD AND NUTRITION

4.5.1 NUTRITION MESSAGES
4.5.2 MECHANICAL DIGESTION
4.5.3 CHEMICAL DIGESTION
4.5.4 FOOD GROUPS
4.5.5 DIGESTION GAME
4.5.6 PRESERVING FOODS

CLUSTER 6 HEALTH AND SAFETY

4.6.1 GROWTH CHART AND AREA MEASUREMENT
4.6.2 TOOTH CHART
4.6.3 SAFETY GEAR
4.6.4 SAFETY AND PUTTING OUT FIRES
4.6.5 MAKING A FIRE
4.6.6 THINGS THAT BURN
4.6.7 SMOKING AND THE LUNGS
4.6.8 ALCOHOL, TOBACCO, AND DRUGS

CLUSTER 7 WAYFINDING AND TRANSPORTATION

4.7.1 BOAT DESIGN
4.7.2 WIND AND SAILS

CLUSTER 8 ENERGY AND COMMUNICATION

4.8.1 PUSH-PULL MEASURING TOOL
4.8.2 FRICTION
4.8.3 STREAMLINING
4.8.4 PRESSURE, SHARP EDGES, AND POINTS
4.8.5 ENERGY OF FALLING OBJECTS
4.8.6 CIRCLES AND SPEED

CLUSTER 9 CONSERVATION, RECYCLING, AND DECOMPOSITION

4.9.1 UNEARTHING AND BURIAL
4.9.2 RECYCLING PROJECT

CLUSTER 10 MATTER, SPACE, AND CONSTRUCTION

4.10.1 LINEAR MEASUREMENT
4.10.2 VOLUME MEASUREMENT
4.10.3 MASS MEASUREMENT
4.10.4 COLLECTING ROCKS
4.10.5 HARDNESS OF ROCKS
4.10.6 SPECIFIC GRAVITY
4.10.7 ROCKS AND SHARP EDGES
4.10.8 MAKING TOOLS FROM ROCK
4.10.9 MAKING FISHING TOOLS
4.10.10 CLOWNS:THINGS THAT FLOAT
4.10.11 CLAY
4.10.12 FIRE AND POTTERY
4.10.13 AIR AND FIRE
4.10.14 FIRE AND OXYGEN
4.10.15 PROPERTIES OF GASES

GRADE 5

CLUSTER 1 LEARNING

5.1.1 THE LEARNING CALENDAR
5.1.2 RESPONSIBILITY
5.1.3 LIBRARY CHECK-OUT
5.1.4 LIBRARY CHECK-IN
5.1.5 WORKING TOGETHER
5.1.6 THINGS I CAN DO FOR MYSELF AND OTHERS
5.1.7 APHORISMS
5.1.8 FRIENDSHIP
5.1.9 CONCEPT AND SKILL INVENTORY

CLUSTER 2 TIME, WEATHER, AND SKY

5.2.1 WEATHER STATION
5.2.2 HEAT INDEX
5.2.3 WEATHER AND ITS PREDICTION
5.2.4 CLOUDS AND FRONTS
5.2.5 TRIANGLES
5.2.6 GNOMON
5.2.7 SIZE OF EARTH
5.2.8 MOON THROUGH A TELESCOPE
5.2.9 HOW BIG AND FAR AWAY IS THE MOON?
5.2.10 PATHS OF CELESTIAL BODIES
5.2.11 MODELS OF THE SOLAR SYSTEM

CLUSTER 3 ANIMALS

5.3.1 PET CARE
5.3.2 BIRD FEEDER
5.3.3 BIRDS I KNOW
5.3.4 CELLS
5.3.5 CELL QUIZ
5.3.6 MALE UROGENITAL SYSTEM
5.3.7 FEMALE UROGENITAL SYSTEM
5.3.8 OVULATION CYCLE
5.3.9 OVULATION AND PREGNANCY
5.3.10 EMBRYOLOGY
5.3.11 BODY CHANGES
5.3.12 BONES
5.3.13 SKELETAL SYSTEM
5.3.14 MUSCLES
5.3.15 MUSCULAR SYSTEM
5.3.16 CHEMISTRY AND BONES
5.3.17 THE SENSES
5.3.18 THE EYE
5.3.19 SOUND
5.3.20 THE EAR

CLUSTER 4 PLANTS

5.4.1 ANNUAL, BIENNIAL, AND PERENNIAL PLANT PROJECT
5.4.2 TREE HARVESTING
5.4.3 TREE PLANTING
5.4.4 TREE OBSERVATION
5.4.5 MEASURING TREES
5.4.6 AGE OF TREES
5.4.7 TREES, SHRUBS, AND GRASSES
5.4.8 GRASSES: WHY DO THEY GROW THERE?
5.4.9 ROOTS
5.4.10 SOIL CONSERVATION

CLUSTER 5 FOOD AND NUTRITION

5.5.1 NUTRIENTS
5.5.2 NUTRIENTS AND CELLS
5.5.3 FOOD LABELING

CLUSTER 6 HEALTH AND SAFETY

5.6.1 GROWTH CHART AND AREA MEASUREMENT
5.6.2 TOOTH CHART
5.6.3 SAFETY DEVICES
5.6.4 ALCOHOL, TOBACCO, AND DRUGS
5.6.5 SEXUALLY TRANSMITTED DISEASES
5.6.6 SEXUALLY TRANSMITTED DISEASE QUIZ
5.6.7 TOBACCO QUIZ
5.6.8 SMOKERS' SURVEY
5.6.9 EX-SMOKERS' SURVEY
5.6.10 SMOKING LAWS
5.6.11 ALCOHOL QUIZ
5.6.12 ALCOHOL LAWS
5.6.13 CHRIS'S STORY
5.6.14 THE PARENTS' STORY
5.6.15 INTOXICATION
5.6.16 DRUG LAWS

CLUSTER 7 WAYFINDING AND TRANSPORTATION

5.7.1 WHERE IN THE WORLD ARE WE?
5.7.2 PLANETARIUM
5.7.3 MAPPING THE SKY
5.7.4 THE NORTH POLE, EQUATOR, AND ECLIPTIC
5.7.5 WHERE IS EARTH?

CLUSTER 8 ENERGY AND COMMUNICATION

5.8.1 PUSHES, PULLS, AND FORCES
5.8.2 TEETER-TOTTERS
5.8.3 THE BALANCE
5.8.4 WHEELS AND AXLES
5.8.5 LEVERS: WHERE ARE THEY?
5.8.6 ARMS AND JAWS
5.8.7 INCLINED PLANES AND SCREWS
5.8.8 BLOCK AND TACKLE
5.8.9 FORCES PROJECTS

CLUSTER 9 CONSERVATION, RECYCLING, AND DECOMPOSITION

5.9.1 CLASS RECYCLING PROJECT
5.9.2 CLASS CONSERVATION PROJECT
5.9.3 DECOMPOSITION AND ARCHEOLOGY
5.9.4 POLLUTION PROJECT

CLUSTER 10 MATTER, SPACE, AND CONSTRUCTION

5.10.1 LINEAR MEASUREMENT
5.10.2 VOLUME MEASUREMENT
5.10.3 CAMERA OBSCURA
5.10.4 CONTROLLING LIGHT WITH LENSES
5.10.5 MAKING A TELESCOPE
5.10.6 STABILIZING THE TELESCOPE
5.10.7 MAKING A MICROSCOPE
5.10.8 MAKING A HYGROMETER
5.10.9 MAKING A BAROMETER

GRADE 6

CLUSTER 1 LEARNING

6.1.1 THE LEARNING CALENDAR
6.1.2 MARS MISSION
6.1.3 LAST YEAR
6.1.4 TOMORROW
6.1.5 THE WORK WORLD
6.1.6 GOALS
6.1.7 CRASH SIMULATION
6.1.8 MARS COMPACT
6.1.9 MARTIAN SIMULATION
6.1.10 THE MISSION CONFERENCE
6.1.11 CONCEPT AND SKILL INVENTORY

CLUSTER 2 TIME, WEATHER, AND SKY

6.2.1 WEATHER STATION
6.2.2 WEATHER AROUND THE UNITED STATES
6.2.3 WEATHER AND LOCAL CLIMATE
6.2.4 WIND HYPOTHESES
6.2.5 PRODUCING WINDS
6.2.6 AIR PRESSURE AND ALTITUDE
6.2.7 WIND AND WATER
6.2.8 ALTITUDE AND TEMPERATURE
6.2.9 MODELS OF AIR
6.2.10 CLIMATIC REGIONS
6.2.11 MARS CLIMATES

CLUSTER 3 ANIMALS

6.3.1 ANIMAL CARE
6.3.2 RAISING FISH
6.3.3 RAISING WORMS
6.3.4 FOOD CHAINS

CLUSTER 4 PLANTS

6.4.1 HYDROPONICS
6.4.2 ALGAE
6.4.3 NUTRIENTS AND BIOLOGICAL WASTE
6.4.4 WATER POLLUTANTS

CLUSTER 5 FOOD AND NUTRITION

6.5.1 NUTRITION INFORMATION
6.5.2 THE KILOCALORIE
6.5.3 WEIGHT WATCHING
6.5.4 MEAL PLANNING
6.5.5 FOOD FOR SPACE
6.5.6 FISH FOR DINNER

CLUSTER 6 HEALTH AND SAFETY

6.6.1 GROWTH CHART
6.6.2 TOOTH CARE
6.6.3 SAFETY DEVICES
6.6.4 DISEASES LITERATURE
6.6.5 SANITATION
6.6.6 DISEASE PRODUCING ORGANISMS
6.6.7 SEXUALLY TRANSMITTED DISEASES
6.6.8 DRUG ABUSE PREVENTION AND TREATMENT
6.6.9 ALCOHOL AND TOBACCO
6.6.10 ENVIRONMENTAL DISEASE TRANSMISSION, PREVENTION, AND TREATMENT
6.6.11 EXERCISE AND HEALTH AND THE MARS MISSION

CLUSTER 7 WAYFINDING AND TRANSPORTATION

6.7.1 FLYING AIRPLANES
6.7.2 FLYING ROCKETS
6.7.3 SPACECRAFT
6.7.4 THE ORBIT OF MARS
6.7.5 WHAT PATH TO MARS ?

CLUSTER 8 ENERGY AND COMMUNICATION

6.8.1 ROCKET PROPULSION
6.8.2 MAGNETISM
6.8.3 ELECTROSTATICS
6.8.4 ELECTRICAL CIRCUITS
6.8.5 ROCK FORMATIONS
6.8.6 METALS FROM ORES
6.8.7 ASYMMETRICAL LEVERS

CLUSTER 9 CONSERVATION, RECYCLING, AND DECOMPOSITION

6.9.1 CLASS RECYCLING PROJECT
6.9.2 CONSERVATION
6.9.3 DECOMPOSITION: A SUMMARY
6.9.4 POLLUTION

CLUSTER 10 MATTER, SPACE, AND CONSTRUCTION

6.10.1 MAKING MEASURING EQUIPMENT
6.10.2 MAKING BALANCES
6.10.3 MAKING AN ELECTROSCOPE
6.10.4 MAKING ELECTROMAGNETS AND CURRENT INDICATORS
6.10.5 MAKING ELECTRIC CELLS
6.10.6 MAKING AN ELECTRIC MOTOR
6.10.7 MAKING AN ELECTRIC SIGNALER
6.10.8 MAKING A SURVIVAL HABITAT

DASH

GRADE 4

MATERIALS LIST

GRADE 4
DASH INSTITUTE MATERIALS LIST

Permanent (borrow or buy and save to reuse for future institutes)

- Tools
  - 2 pliers (1 regular, 1 needlenose)
  - 1–2 hammers
  - 1 hand saw
  - 1 shovel (share with other grades)
  - 1 small steel file
  - 1 wire cutters
  - 1–2 glue guns with glue sticks
  - 1 water hose (share with other grades)
  - 1 pair tin snips or universal scissors
  - gloves for protection from fire
- 1 light socket and cord or trouble light
- 1 20 watt bulb if hatching eggs
- 1 strong flashlight with batteries
- 2 basket or volley balls
- 3–5 tennis balls (recycled okay)
- binoculars/opera glasses for bird watching (opt.) (share with Grade 5)
- 1 hand held one-hole paper punch
- 1 pair scissors
- 1 stapler with staples
- 1 protractor
- 1 globe (may be shared with other grades)
- world almanac, current year (share K-6)
- used maps, U.S., state, local
- 2–4 buckets or any container for carrying water (share with other grades)
- 1 °C and °F thermometer, large preferred
- 1 heavy tarpaulin, min. 9 ft.x12ft.(share with other grades)
- 12"x12"x1" plywood
- 1-2 pair, metal tongs
- 1-2 pieces sand paper
- 2 12" ruler, 1 wood, 1 plastic

- 1 film strip or slide projector (share with others)
- 1 overhead projector
- 1 electric fan (share with other grades)

- 1 golf ball (recycled okay)
- 1 ping pong ball (recycled okay)

- First Aid Kit

- 1 small metal ash can with lid (15-20 gallon)-check with trainer (for kiln)

Expendables (most items can be found at discount department stores)

- 1 box nails, assorted sizes
- 1 c. builder's lime or 1 oz. Bromothymol Blue
- 1 8-penny nail
- 1 box aluminum foil
- 1 roll plastic wrap
- 2 rolls paper towel if classroom not supplied
- 30 cups, soft, plastic 9-oz. transparent (Solo)
- 1 pkg. straws
- 2 pkg. (50) 8" or 9" thick paper plates, undivided (Chinet)
- 1 box (25) plastic resealable qt. freezer bags
- 1 box (20) 30 gal. trash bags
- 1 pkg. wooden skewers
- 1 pkg. disposable wooden chopsticks
- 1 pkg. (20) Styrofoam cups
- 1 box food coloring (share with other grades)
- 1 pt. vinegar (share with other grades)
- 4–5 eating-size whole, not gutted, fish
- 1 pkg 5"X8" index cards (100)
- 1 doz. chicken eggs from grocery store
- 25 m. heavyweight string or cord
- 4–6 candles or 1 pkg. votive or warming candles in metal holders
- 1 box safety matches
- charcoal, 1 small bag-check w/ trainer (for kiln)
- charcoal starter, 1 can-check w/ trainer (for kiln)
- 1 small bag woodchips-check w/ trainer (forkiln)
- 1 roll adding machine tape
- 1 box brass fasteners, 1.5" length
- 1 pkg. index cards, 3 x 5 lined
- 1 box paper clips (small)
- 1 box paper clips (jumbo)
- 1 pkg. push pins
- 1 box rubber bands (asstd.)
- 1 bottle white glue
- 1 set colored markers
- 1 ultra fine line permanent marker-black
- 1 yellow or white tablet, legal size
- 20–30 sheets chart paper (1 pad) or 36" wide butcher paper
- 1 25 ft. piece (18", 24", or 36" white) butcher paper or DASH calendar paper
- 3–4 rolls duct tape
- 2 rolls masking tape, 1/2 in.
- modeling **clay**, 1 box per 2 participants
- 1 pkg. balloons (asstd, including long type)
- birdseed, 2-5 lb. (share with grade 5)
- 1 small bottle hydrogen peroxide
- 1 pkg. large, fat needles
- 2 yd. plastic tubing, 1/4 in. (aquarium tubing)

Permanent (borrow or buy and save to reuse for future institutes)	**Expendables** (cont.)
	8 oz. vinegar (share with other grades) 1 small box baking soda (share with other grades) small amout, steel wool 1 box binder clips, 3/4" 4–6 plastic/latex (surgical) gloves 1 6 volt battery 20 wood clothes pins 1 small pkg. alkaseltzer 1 small package yeast, 3-6 packets 1 small funnel (share with grade 2-3) 1 metal fork and small platic bowl or small mortar and pestle 2-3 unfiltered cigarettes each participant will need 1 block of fine grain styrofoam **OR** balsa wood, 2"x2"x4" sand--1/2 small bucket (1 gallon) 2-3 wood dowels, 36" x 1/4" or 3/8" diameter 1 package aluminum pie pans (recycled fine) saw dust (20 gal.)-check with trainer (for kiln)
Permanent Science Supplies (borrow or buy and save to reuse for future institutes)	**Expendable Science Supplies**
3-dimensional human torso or anatomic charts (share with other grades) 10 hand lenses (can be shared) 1 incubator 1 strong magnet (share with other grades) 1 magnetic compass 1 meter stick 2–3 small thermometers, °C & °F 1 aquarium (opt.) (share with other grades) set, gram weights (plastic or cube-o-grams) (share with other grades)	2–3 strips cobalt chloride paper (share with other grades) 1 vial or roll wide scale 0-12 or 14 pH paper 1 doz. chicken eggs, fertilized

Materials Requested from Participants in DASH Institutes Grade 4

- 1 pair scissors
- White glue
- Scotch tape
- Assorted colored markers
- 1 ultra fine line permanent marker
- 3-ring loose leaf paper
- Baby picture of self
- 10 1/2 meters **heavy** string or cord
- 2 12-inch wooden rulers w/3 holes if possible
- Natural clay from yard or streambed (1-2 cups)
- Optional: stapler, masking tape, duct tape, paper punch, coffee mug
- Recycled materials to save **only as available** and to bring in as requested.
  - aluminum pie pans
  - bricks
  - tin cans (6 oz.-1 gallon sizes)
  - 2 to 3-LB. coffee can w/plastic lid
  - large cardboard sheets
  - corrugated cardboard boxes
  - fabric & yarn scraps
  - 35mm film canisters, clear & black
  - jars w/lids (baby food & qt.)
  - milk cartons (all sizes)
  - modeling clay
  - newspaper
  - nylon stockings (used)
  - plastic bleach or milk bottles (gallon)
  - plastic soda bottles w/caps (1/2-liter, 1-liter & 2-liter)
  - plywood (assorted pieces, including 12"x12"x 3/4"or thicker)
  - rocks (assorted)
  - sticks and dowels (assorted, golf ball to softball sizes)
  - Styrofoam pieces (assorted blocks & trays)
  - window screening (used)
  - 2-3 thin wire hangers
  - wooden clothespins or small binder clips (2)

Ideally each classroom will have a classroom pet during the institute. Participants will be asked on the first day to bring one in for their class if available. Grade 4 needs mice or small rodents, pet food, and bedding.

Participants may be asked to bring additional supplies and tools as needed by their particular class.